# ANNUAL REPORT 1996-97

## COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

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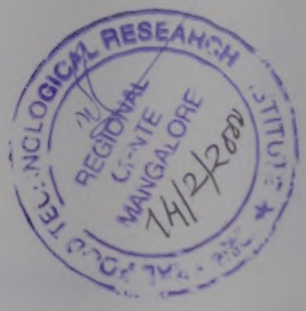
# 1996-97



## COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH

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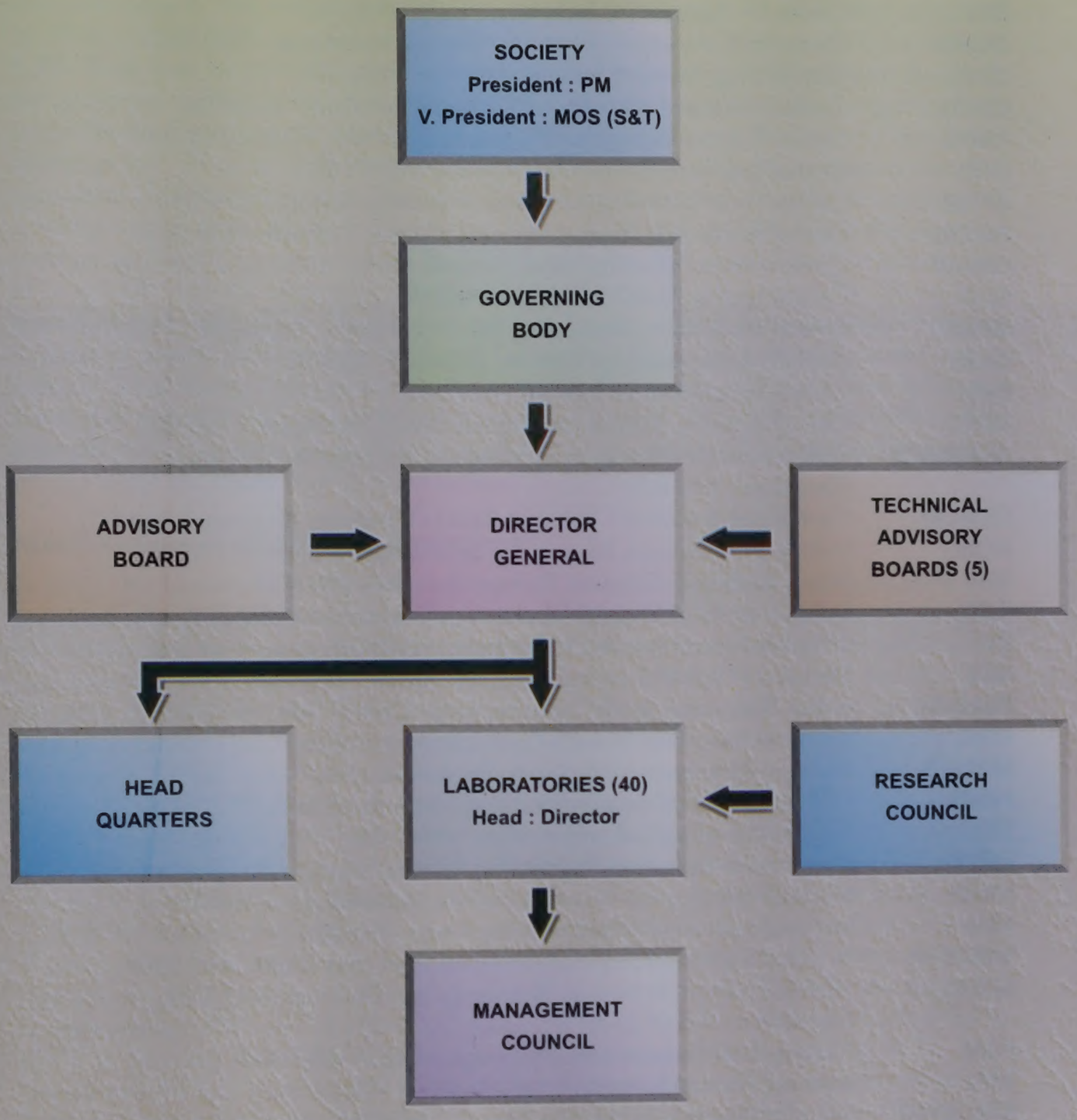
# CSIR ORGANISATIONAL STRUCTURE




| | | |
|---|---|---|
| PRESIDENT | : | SHRI P.V. NARASIMHA RAO (UPTO MAY 16, 1996)<br>SHRI A.B. VAJPAYEE (W.E.F. MAY 17 TO MAY 31, 1996)<br>SHRI H.D. DEVE GOWDA (W.E.F. JUNE 01, 1996) |
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| DIRECTOR GENERAL | : | DR. R.A. MASHELKAR |

# CSIR Establishments

| | |
|---|---|
| **CBRI** | Central Building Research Institute, Roorkee-247 667 |
| **CBT** | Centre for Biochemical Technology, Delhi - 110 007 |
| **CCMB** | Centre for Cellular and Molecular Biology, Hyderabad - 500 007 |
| **CDRI** | Central Drug Research Institute, Lucknow - 226 001 |
| **CECRI** | Central Electrochemical Reserch Institute, Karaikudi - 623 006 |
| **CEERI** | Central Electronics Engineering Research Institute, Pilani - 333 031 |
| **CFRI** | Central Fuel Reserch Institute, Dhanbad - 828 108 |
| **CFTRI** | Central Food Technological Research Institute, Mysore - 570 013 |
| **CGCRI** | Central Glass and Ceramic Research Institute, Calcutta - 700 032 |
| **CIMAP** | Central Institute of Medicinal & Aromatic Plants, Lucknow - 226 016 |
| **CLRI** | Central Leather Research Institute, Madras - 600 020 |
| **CMERI** | Central Mechanical Engineering Research Institute, Durgapur - 713 209 |
| **CMRI** | Central Mining Research Institute, Dhanbad - 826 001 |
| **CRRI** | Central Road Research Institute, New Delhi - 110 020 |
| **CSIO** | Central Scientific Instruments Organisation, Chandigarh - 160 020 |
| **C-MMACS** | CSIR Centre for Mathematical Modelling & Computer Simulation, Bangalore - 560 037 |
| **CSMCRI** | Central Salt & Marine Chemicals Research Institute, Bhavnagr - 364 002 |
| **IHBT** | Institute of Himalayan Bioresource Technology, Palampur - 176 061 |
| **IICB** | Indian Institute of Chemical Biology, Calcutta - 700 032 |
| **IICT** | Indian Institute of Chemical Technology, Hyderabad - 500 007 |
| **IIP** | Indian Institute of Petroleum, Dehradun - 248 005 |
| **IMT** | Institute of Microbial Technology, Chandigarh - 160 036 |
| **INSDOC** | Indian National Scientific Documentation Centre, Delhi - 110 067 |
| **ITRC** | Industrial Toxicology Reserch Centre, Lucknow - 226 001 |
| **NAL** | National Aerospace Laboratories, Bangalore - 560 017 |
| **NBRI** | National Botanical Research Institute, Lucknow - 226 001 |
| **NCL** | National Chemical Laboratory, Pune - 411 008 |
| **NEERI** | National Environmental Engineering Research Institute, Nagpur- 440 020 |
| **NGRI** | National Geophysical Research Institute, Hyderabad - 500 007 |
| **NIO** | National Institute of Oceanography, Goa - 403 004 |
| **NISCOM** | National Institute of Science Communication, New Delhi - 110 012 |
| **NISTADS** | National Institute of Science Technology and Development Studies, New Delhi - 110 012 |
| **NML** | National Metallurgical Laboratory, Jamshedpur - 831 007 |
| **NPL** | National Physical Laboratory, New Delhi - 110 012 |
| **RRL, BHO** | Regional Research Laboratory, Bhopal - 462 026 |
| **RRL, BHU** | Regional Research Laboratory, Bhubaneshwar - 751 013 |
| **RRL, JM** | Regional Research Laboratory, Jammu Tawi - 180 001 |
| **RRL, JT** | Regional Research Laboratory Jorhat - 785 006 |
| **RRL, TVM** | Regional Research Laboratory, Thiruvananthapuram, - 695 019 |
| **SERC,G** | Structural Engineering Research Centre, Ghaziabad - 201 001 |
| **SERC,M** | Structural Engineering Research Centre, Madras - 600 113 |

# Overview

## The Performance

The year, 1996-97, the sixth since the initiation of the structural readjustment programme and also the concluding year of the Eighth Five Year Plan witnessed a slowdown in the economic growth. The rate of growth in the manufacturing sector declined from a high of 12.5% to around 6.4%, and the growth in dollar value of exports fell from 20.7% to around 5.3%. There was, as a result, general scarcity of financial resources in the economy including the government. The consequent effect on the CSIR was pegging of the budgetary Plan support by the Government at the 1995-96 level, i.e. at Rs. 161 crore. This posed a formidable challenge to CSIR as in 1995-96 itself significant Plan funds had to be diverted to meet the committed liabilities on the Non-Plan side. The deployment of resources for developmental activities was severely affected. Nonetheless the performance of CSIR during the year was satisfactory. The ECF increased from Rs. 177 crore to Rs. 204 crore showing a growth rate of over 15%; and the laboratory reserves increased from Rs. 42 crore to Rs. 54 crore, a growth rate of nearly 35%. The upward trend in foreign patents filing continued with the number of patents filed rising from 58 to 71. However, there was a slight dip in the Indian patents' filing, owing to the emphasis on improving the quality of patents filed. While the number of research papers contributed remained at around 2800 (with nearly 2200 in SCI journals) their aggregate impact factor increased from 1980 to 2175 raising the average impact factor per paper from 0.90 to 0.98.

## Mobilisation of Additional Resources

In 1989, the Government of India in association with and support of the World Bank had mounted an Industrial Technology Development Project (ITDP) to enhance the level of productivity and technology of the Indian industry. One component of the ITDP pertained to strengthening the capacity of the technical institutions (TI) to provide S&T facilities and expertise of value and use to the Indian industry. This support to TI was to be provided through a soft loan (and not grant) assistance. The funds for TI component were available to the Government of India at zero interest with a maturity period of 30 years. Its management was assigned to ICICI. The funds were thus available to TIs through ICICI at zero interest (with a service fee of 0.25%) for a period of ten years. Recognising the attractiveness of the loan programme, CSIR catalysed loan for five laboratories, which have since put the facilities created to good use and advantage. As the project was to terminate in December 1996 CSIR HQs. endeavoured to scout around to formulate more projects for support under the IT component. After detailed discussions with laboratories and ICICI, four projects for : (a) restructuring R&D facilities at CGCRI; (b) capability strengthening of IICT; (c) technological re-engineering of IIP; and (d) restructuring of CSIR HQs. were formulated and submitted to ICICI. In February 1997, the ICICI approved of loan assistance aggregating to Rs. 49.7 crore for all the four projects. It is envisaged that this one time resource input would greatly help to enhance the levels of productivity and competitiveness of these three laboratories and the HQs.

## Coordinated Programme on Development and Commercialization of Bioactive Substances from Plant Sources

Recognising that the full potential of our rich biodiversity and the heritage of traditional knowledgebase in herbal medicines could be realised through appropriate R&D inputs and intervention of modern science and technology, CSIR mounted a major coordinated

programme to synergise the core competencies of its laboratories and external agencies with the objective to:

- tap formal and non-formal knowledgebases to discover new bioactive molecule leads as therapeutics;
- search and develop new pest management agents; and
- standardise herbal therapeutic formulations.

Working group meeting for the co-ordinated programme on 'Development & Commercialisation of Bioactive Substances from Pant Sources'

A high level Apex Committee was constituted to plan, co-ordinate and monitor the programme. The programme has commenced with networking of 18 laboratories and external agencies. In the first phase, extracts from 160 plants have been identified for screening against 18 diseases. Also in order to have uniformity of R&D practices amongst the participants, protocols have been standardised for plant material collection, storage, transportation, extraction and screening. Efforts have been mounted to develop/acquire high throughput screens (which are generally proprietary for the identified disease vectors) so as to deal with the large number of extracts to be screened.

## Ninth Five Year Plan of CSIR

In November, 1995 the Planning Commission had constituted a Working Group to formulate the Ninth Five Year Plan of CSIR. The Working Group in turn had constituted 14 sectoral subgroups in the socio-economic sectors of interest to CSIR. The sectoral subgroups reviewed the R&D output, achievements and contribution made by CSIR during the Eighth Five Year Plan and based on SWOT analysis drew up sectoral strategic perspective plans indicating the sector-wise outputs and the deliverables as also the requirements of corresponding resource inputs. Concurrently the laboratories were requested to provide the broad contours of their Ninth Five Year Plans. The sectoral plans and the laboratories' plans were juxtaposed and dovetailed to arrive at a draft composite Five Year Plan for the CSIR. The draft Plan was considered by the Working Group and the final Report arrived at. The Report of the Working Group interalia envisaged an outlay of Rs. 4085 crore for the Ninth Five Year Plan of which only Rs. 1835 crore is to be financed through budgetary support and the rest (55%) is to be financed from resources generated by CSIR itself! The Working Group also recommended modernisation and upgradation of R&D equipment and facilities at an estimated investment of Rs. 350 crore of which over Rs. 100 crore is to be met from CSIR's internal resource generation. Further, the Working Group also envisaged an investment of Rs. 600 crore for

new facilities to be set up during the Ninth Plan of which Rs. 260 crore would be financed from internal resources. Based on this envisaged level of investment, the Working Group set stretched targets for the deliverables in each of the socio-economic sectors. Table below gives some of the targets to be realised collectively by CSIR over the Ninth Plan period.

**Table : Targets set for Ninth Five Year Plan period (1997-2000)**

| | |
|---|---|
| External Cash Flow Generation | Rs. 2250 crore |
| Patents Filing (Nos.)<br>•India<br>•Abroad | <br>3350<br>575 |
| Earning from overseas | $ 106 million |
| Total cumulative impact factor of all publications | 18,700 |
| Exclusive technology portfolio (Nos.) | 15 |
| New industrial production to be catalysed | Rs. 2550 crore |
| Rural employment generation to be catalysed | 150 lakh mandays |

## Foreign Business Development

CSIR continued its forays in the global S&T marketplace by venturing into promising markets hitherto unexplored. It participated in the Second Techno Messe Kansai, held in Japan in February 1997. As a result of this participation, CSIR has already been able to make a small dent and get a toe-hold in the highly discerning Japanese S&T marketplace. CSIR also participated in Petrotech '97 held in March 1997 in Vietnam, a burgeoning and expanding economy. Some promising leads have emerged. It is envisaged that such initiatives would be further enlarged during the course of the next few years in keeping with the goal of CSIR to generate over $100 million from foreign business over the Ninth Five Year Plan.

CSIR display at the second Techno Messe Kansai at Osaka, Japan.

# Our Resource Base

## 1. Infrastructural

| | | Number | |
|---|---|---|---|
| * | Laboratories/Institutes | 40 | (40) |
| * | Extension/ Field/ Regional/Polytechnology Transfer Centres | 80 | (80) |

## 2. Manpower

| | | | |
|---|---|---|---|
| **Total Staff** | | 23,120 | (22,420) |
| * | Total S&T Staff | 17,440 | (17,570) |
| | • Scientists (Group IV) | 5,860 | (5,550) |
| | • Technical (Group III) | 3,290 | (3,700) |
| | • Technical (Group V+II+I) | 8,290 | (8,320) |
| * | Total Administrative & non-technical | 5,680 | (4,850) |

## 3. Financial

| | | Rs. Crore | |
|---|---|---|---|
| * | Government plan allocation | 161.0 | (160.0) |
| * | Government non-plan allocation | 283.0 | (251.7) |
| * | Extra budgetary resource generation | | |
| | • From Contract R&D and Consultancy | 190.3 | (167.0) |
| | • Miscellaneous receipts (non-R&D) | 21.8 | (19.1) |
| | • Laboratory reserves | 53.8 | (42.1) |

**NB:** Figures in parenthesis correspond to the previous year i.e. 1995-96

# Our Performance in 1996-97

## 1. Contributions to Economy

| | Rs. Crore | |
|---|---|---|
| * Industrial production based on CSIR know-how | 3,600 | (3,000) |
| * Saving in productivity accruing through CSIR R&D efforts | 215 | (210) |

## 2. Science Output

| | Number | |
|---|---|---|
| * Papers contributed | 2807 | (2,859) |
| * Patents | 279 | (318) |
| • Filed in India | 209 | (260) |
| • Filed abroad | 71 | (58) |
| • In force in India | 416 | (515) |
| • In force abroad | 83 | (75) |

## 3. Technological Output

| | Number | |
|---|---|---|
| * New know-how licensed | 40 | (46) |
| * Licensing agreements executed | 160 | (190) |

## 4. External S&T Human Resource Development

| | Number | |
|---|---|---|
| * Research Fellows/Associates supported | 5519 | (5223) |
| * Emeritus Scientists in position | 134 | (143) |
| * Pool Scientists (SRAs) in position | 444 | (428) |
| * Research schemes supported | 620 | (542) |

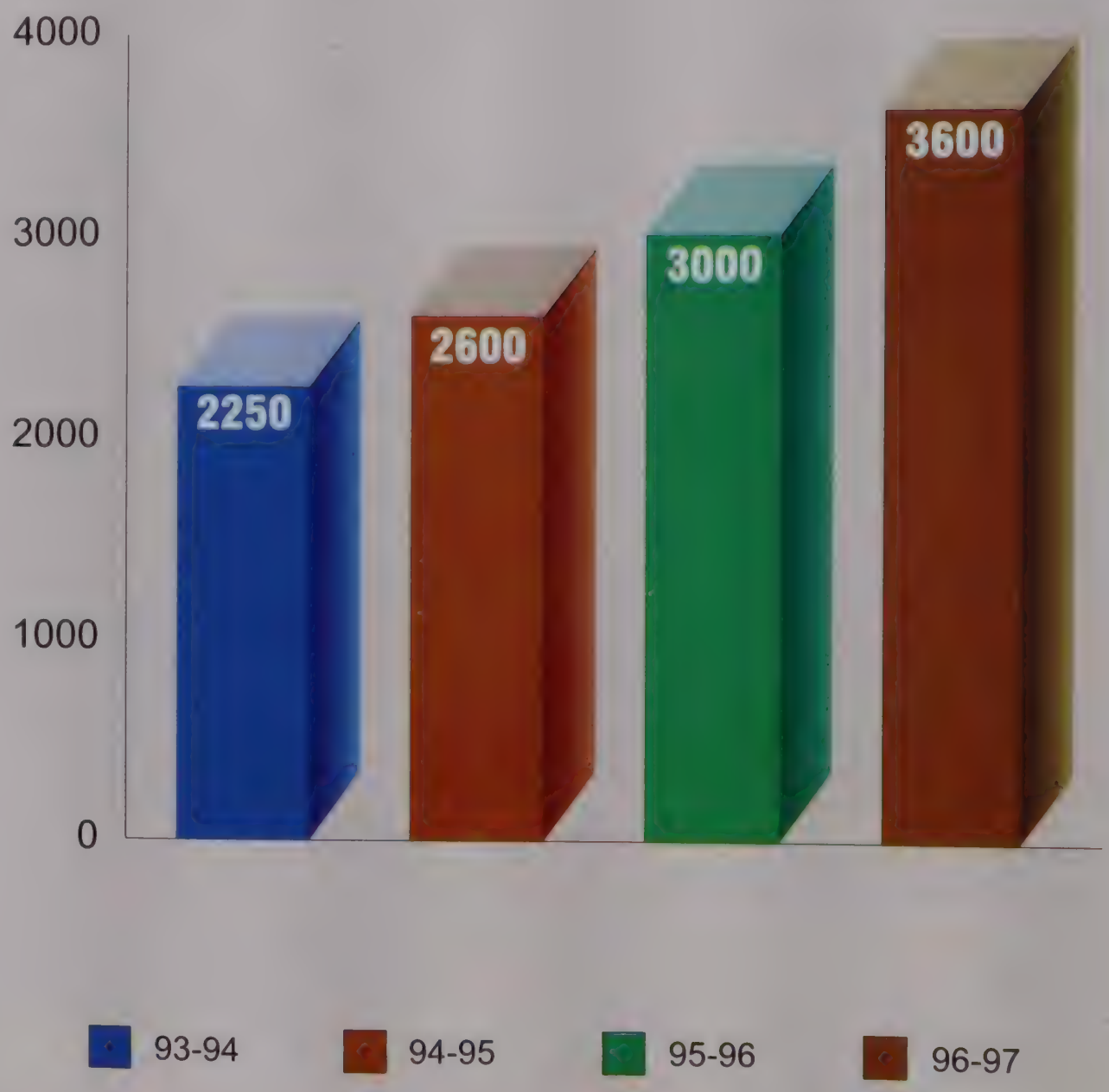
## 5. Resource Mobilisation

| | Rs. Crore | |
|---|---|---|
| * External cash inflow total | 204 | (177) |
| * Contract value of projects on hand | | |
| • Contract research | 300 | (265) |
| • Consultancy | 50 | (45) |

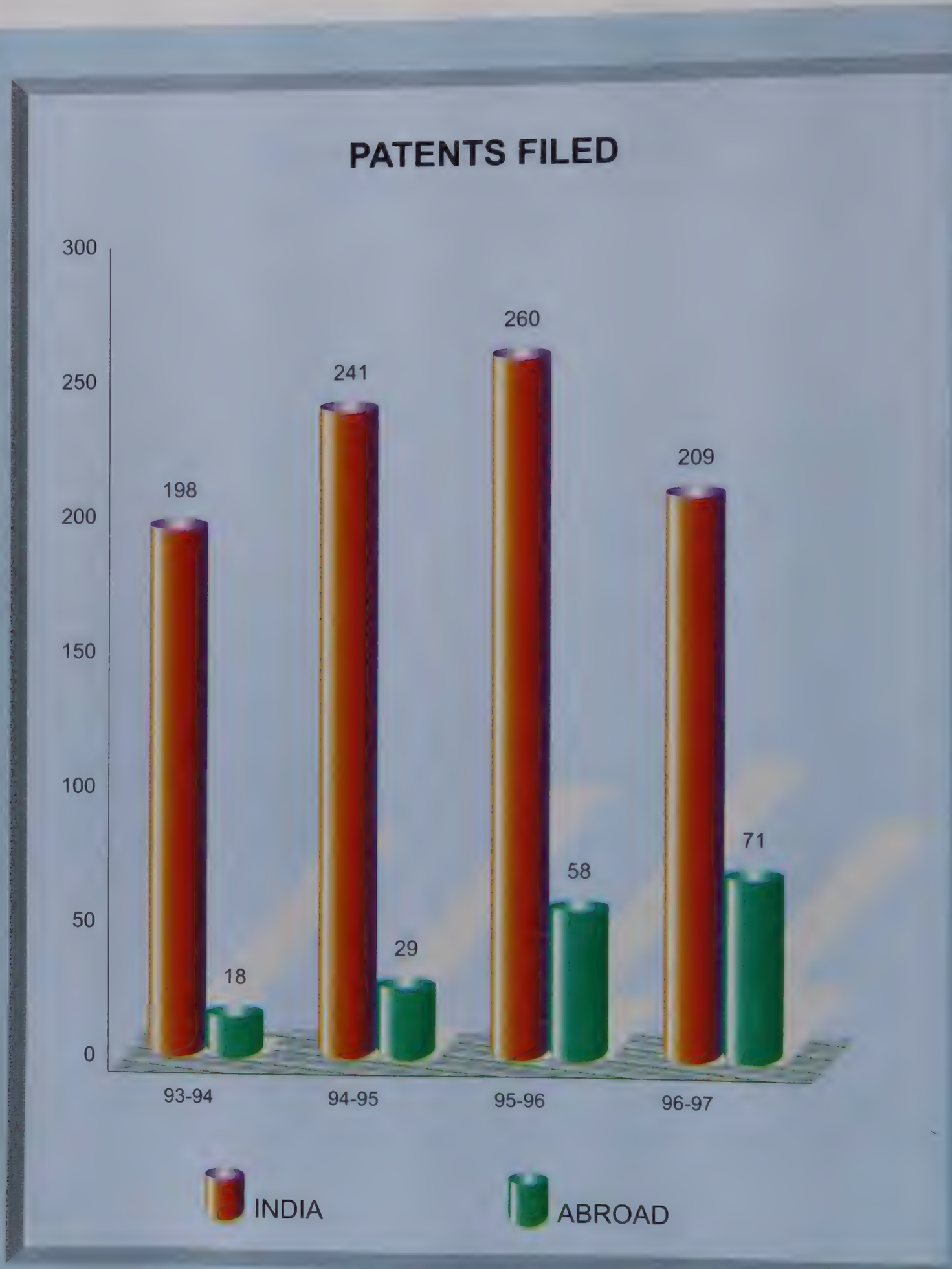
**NB:** Figures in parenthesis correspond to the previous year i.e. 1995-96

# ANNUAL INDUSTRIAL PRODUCTION BASED ON CSIR KNOWHOW

*(Rs. Crore)*



# EXTERNAL CASH INFLOW
## Contract R&D and Consultancy Only
*(Rs. Crore)*

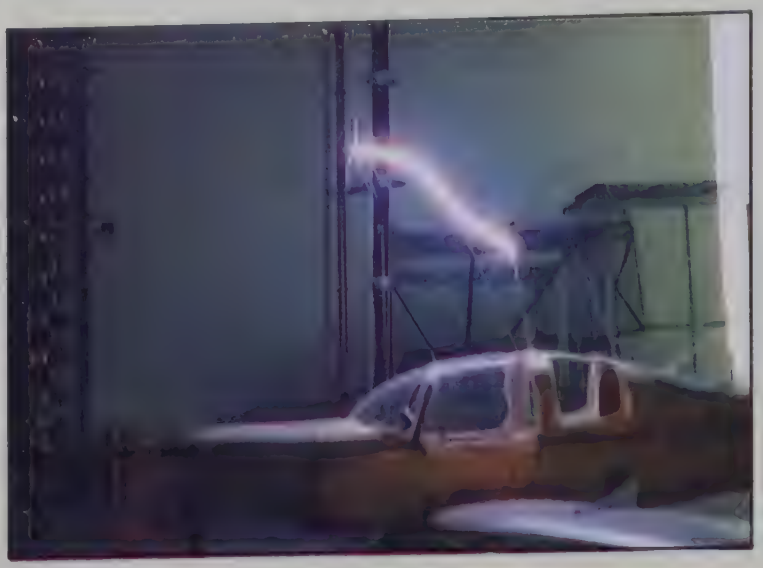

PATENTS FILED
300
250
200
150
100
50
0
198
18
241
29
260
58
209
71
93-94
94-95
95-96
96-97
INDIA
ABROAD

# Knowhow Licensed for the First Time

| KNOWHOW / TECHNOLOGY | LICENSEE(S) |
|---|---|
| • **Biotechnology** | |
| 1. Fungal phytase enzyme **(CFTRI)** | Kaypees Biotech (P) Ltd.,Mysore |
| 2. Osmo tolerant yeast **(CFTRI)** | The Andhra Sugars Ltd., Tanaku |
| 3. CD strip for quick detection of adulteration of butter yellow **(ITRC)** | Nelofe, Lucknow |
| 4. Seaweed biofertilizer **(NIO)** | Pralshar Bio Product Pvt. Ltd., Goa |
| • **Chemicals and allied products** | |
| 5. Diamond powder incorporated metal matrix coating on steel disc **(CECRI)** | Anjenkhan, Jaipur |
| 6. Polyurethane epoxy coating for concrete structure **(CECRI)** | Grand Polycoats, Vadodara |
| 7. Yellow chromating Formulations for aluminium **(CECRI)** | Sakhti Enterprises, Hyderabad |
| 8. Jewellery enamel **(CGCRI)** | Manti Basak, Calcutta |
| 9. Phenyl acetic acid by CO route **(IICT)** | RCF Ltd., Rasayani |
| 10. Indelible tattooing ink **(IICT)** | Shri A. Maithan, New Delhi |
| 11. Cyclopropylamine **(IICT)** | Sterling Basic Organics, Madras |
| 12. 2,4-dichlorofluorobenzene **(IICT)** | Sterling Basic Organics, Madras |
| 13. T.V. picture tube lacquers **(IICT)** | Ravi Corporation |
| 14. Tetrabutyl Ammonium Hydroxide & tetrapropyl ammonium hydroxide **(NCL)** | Alkyl Amine Chemicals Ltd., |
| 15. Polycarbonates **(NCL)** | General Elecric Company, USA |
| 16. Tartaric acid **(NCL)** | Indus Natural Products P. Ltd., Pune |
| 17. Polymerisation & oligomerisation of alpha olefins **(NCL)** | IOCL |
| 18. 3-amino-4,5-dimethyl isoxazole **(NCL)** | Cibatul Ltd., |
| 19. Polyol from waste stream high boiler material **(NCL)** | Bombay Dyeing & Mfg. Co. Ltd., Mumbai |
| 20. Paraffin oxidation catalyst **(NCL)** | Neste Oy, Finland |
| 21. Sol-gel alumina abrasives **(RRL,Tvm)** | Carborandum Universal Ltd., Madras |
| • **Agrochemicals** | |
| 22. Prenol **(IICT)** | Montari Industries Ltd., New Delhi |
| 23. Pheromones for groundut **(IICT)** | Pheromone Chemicals, A.P. |

| | |
|---|---|
| • **Drugs & Pharmaceuticals** | |
| 24. Halofantrine **(IICT)** | Cadila Laboratories, Ahm'bad |
| 25. Loratidine **(IICT)** | Cadila Laboratories, Ahm'bad |
| 26. Lisinopril **(IICT)** | Cadila Laboratories, Ahm'bad |
| 27. Pefloxacin **(IICT)** | Sterling Basic Organics, Madras |
| 28. Dipyridamole **(IICT)** | Coramandel Fertilizers Ltd, Visakhapatnam |
| 29. Fluconazole **(IICT)** | Cadila Laboratories, Ahmedabad |
| 30. Calcium pantothenate **(IICT)** | Dai ichi Karkaria Ltd, Mumbai |
| 31. Cefixime **(IICT)** | Cadila Laboratories, Ahm'bad |
| • **Building Materials** | |
| 32. Cement free dense flowing castables **(CGCRI)** | Refcom (India) Pvt. Ltd., Purulia |
| • **Machinery & Equipment** | |
| 33. Stitch bonding machine **(CMERI)** | Priti Machines, Calcutta |
| 34. Twin press screw for extraction of Palm oil **(CMERI)** | i. Ark Industries Products Pvt. Ltd., New Delhi<br>ii. Japro Engg. Pvt. Ltd., Mumbai<br>iii. Wilson Engg. Enterprises, Coimbatore |
| 35. Green roof strong prop **(CMRI)** | Moon Mine Engineering Service, Howrah |
| • **Electronics & Instrumentation** | |
| 36. Zinc oxide/tin oxide thin films gas sensors for liquified petroleum gas **(CGCRI)** | Victory Microelectronic Ltd., Calcutta |
| 37. Scanning tunneling microscope **(CSIO)** | Vacuum Instruments Co., New Delhi |
| 38. Air transparency measuring system **(NAL)** | Opto Electronics |
| **Others** | |
| 39. Staining technique for differentiation of basmati rice **(CFTRI)** | Marico Industries Ltd., Mumbai |
| 40. Synthetic mullite & zirco mullite **(CGCRI)** | Indian Refractory Makers Association, Calcutta |

# Aerospace



Lightning Protection Test for HANSA -Type Certification compliance

Hot filament CVD unit set up at NAL

Ejector Ramjet Flame

NAL vigorously pursued its ongoing civil aviation programmes for the design and development of a two-seater all composite trainer aircraft (HANSA) and the 14 seater light transport aircraft (SARAS). In regard to the Light Combat Aircraft (LCA), NAL was assigned to develop the composites fuselage. Also NAL greatly contributed to the successful in-flight simulation of the control-law and carried out tests at its National Trisonic Aerodynamic Facilities on LCA air-intakes, vortex control etc to build databases for refining the development of LCA. Some of the more salient-achievements during the year are given here.

## SCIENCE

### Reynolds Averaged Navier-Stokes equations (RANS)

An advanced code, named Jumbo 3-D - has been developed by NAL for computing fluid flow from complex configurations. The code solves Reynolds averaged Navier-Stokes equations using a simple algebraic turbulence model, boundary-fitted grid and cell-vortex finite volume space discretisation. Definite schemes are included to accelerate the convergence to steady state. The relevant grid generation packages are also developed simultaneously. The code has been written for 2 and 3 - dimensional RANS Versions as also an Euler Version keeping the same structure and basic requirements to improve the versatility. The results obtained by the code for known complex flows compare very well with available experimental data. The code has also been modified to take into account some important study effects and the test cases have been computed. These codes give a greater insight into the physical understanding of the phenomena.

Another version of the RANS code for incompressible flow has also been developed and has been applied successfully for computation of flow around marine propellers to solve problems of practical interest. Yet another version of the code applicable to hypersonic flows has also been developed. Using the code NAL has completed several studies for Vikram Sarabhai Space Centre (VSSC) for launch vehicle applications.

### Active noise control

Acoustic noise in the high frequency range is suppressed by using passive absorbing material. Noise in the low frequency range would however need absorbers of abnormal size. Thus an effective way to control this noise is to create and superpose anti-noise on it-called active noise control. This involves picking up the noise and adjusting its phase and magnitude by an adaptive filter so as to cancel the ambient noise. After detailed, studies, NAL has developed a methodology for active noise control using a single channel system.

However real life applications require generating multi-channel noise controllers and appropriate algorithms for the adaptive filters. NAL is accordingly developing a multichannel system for noise control for enclosures like automobiles, aircraft cockpits and air cabins which would also be used for the 14 seater SARAS aircraft being developed by the laboratory.

### Drag reduction on swept wing

Drag experienced by flight vehicles is a major source of losses in all flight related problems. Experimental research conducted earlier at NAL on 3M riblets was extended to swept wing with GAW(2) airfoils at low speeds. The results have shown that riblets (shallow and closely spaced grooves) aligned to freestream direction can result in a drag reduction of upto 8%. However, a rapid fall in effectiveness was observed at higher incidences. Analysis of the

contributing factors suggests the need for aligning the riblets to the local surface direction for optimum drag reduction.

In other drag reduction studies parametric tests were conducted on generic multi-step after-bodies relevant to projectiles and rockets to understand the after-body drag and reduce its contribution to the total drag. NAL's research programme on drag reduction is contributing not only to a better understanding of the phenomenon itself but also to evolve design guidelines for reduction of drag experienced by a variety of flight vehicles.

### Ejector ramjets

Studies have revealed that best features of rockets and air breathing engines can be combined in a composite engine. High performance ejector ramjets could be employed very effectively in such composite engines particularly when the system is operated in the low speed mode. A complete understanding of the system is essential to design practical propulsion systems based on these concepts. A proof-of-concept experiment was designed by NAL under project sponsored by VSSC and demonstrated to prove this concept. Ejector ramjet thrust augmentation ratios greater than unity at simulated take-off conditions have been achieved successfully.

A test-rig to test such ejectors has been built for conducting extensive experiments and build a database which would be essential for providing design input for designing this type of systems. Also a combustor test facility for scramjets has been set up under a programme sponsored by DRDO wherein supersonic combustion of both hydrogen and hydrogen aided kerosene has been successfully demonstrated.

## TECHNOLOGY

### Type certification for HANSA-3

One factor that threads through different stages of aircraft development is its type certificate, the document which prescribes the quality control and adequate system requirement that enables one to trace any defect to its root cause. Indeed the type certificate is thus the bedrock on which all activities relating to the aircraft rest.

Hitherto the U.S. Federal Aviation Authority's Federal Aviation Rules (FAR) - Part 23 were the dominant type certification basis for civil aircraft upto all-up weight (AUW) of 5700 kg. In recent times, the European Joint Airworthiness Requirements for Very Light Aircraft (JAR-VLA) is the rational elimination of excessive demands for very light and low-speed aircraft which are otherwise essential for large high speed aircraft involving large masses, velocities and energies. The NAL effort for type certification is centred around the JAR-VLA route.

NAL has set-up a quality control assurance unit and worked closely with the R&D and Civil Airworthiness Departments of DGCA in seeking type certification for the all-composite HANSA aircraft. Satisfactory levels of quality control in all aspects of HANSA-3 certification has been achieved and NAL has secured approval of DGCA for prototype fabrication and integration of HANSA-3, inspection of composite material/ component using NDT methods and chemical tests of matrix and metallic materials. The type-certificate for HANSA-3 is expected by the year end.

### Chemical vapour deposition (CVD) diamond film for abrasive applications

CVD diamond film will soon replace the conventional diamond plus resin and diamond plus metal composites for abrasive applications. NAL has initiated work on the development of CVD diamond film under a Indo-German collaborative project based on its in-house surface engineering expertise.

The NAL technology takes a hot filament activation route for the deposit of thick films of diamond suitable for industrial applications. The characteristics of film obtained from this method are extremely attractive and the technology has a good potential for general industrial as well as a few critical aerospace applications.

## SERVICES

### Composite material radome design

The Indian Meteorological Department is to locate radars along the eastern coast to sense and warn about characteristic severe cyclonic storms. The radars are being designed and developed by ISRO Telemetry Tracking and Command Network ISTRAC.

NAL has been assigned the responsibility for the design of radomes of composite material. NAL has successfully designed the 12.88 m diameter spherical radome to be made from rigid PU foam GFRP sandwich panels and bolted together to form the geodesic dome.

### Nickel foil sheets

Eight sets of nickel foil sheets (each of 14 sheets) produced as per process developed and standardised at NAL were supplied to M/s Bhartiya Udyog Ltd., New Delhi for making hydraulic cylinders. Foils of seven different dimensions of uniform thickness of 0.25 0.03 mm were prepared.

## HUMAN RESOURCES DEVELOPMENT

### Training in FRP tooling and product moudling

NAL in association with Centre for Technology Development (CTD) and SISI conducted a two week training programme on FRP tooling and product Moulding process for entrepreneurs.

### Training in information technology

The Advanced Information Technology Centre (AITC) at NAL supported by CTD conducted 28 training programmes on GIS, Auto CAD etc. for CSIR and external personnel.

## RECOGNITION & AWARDS

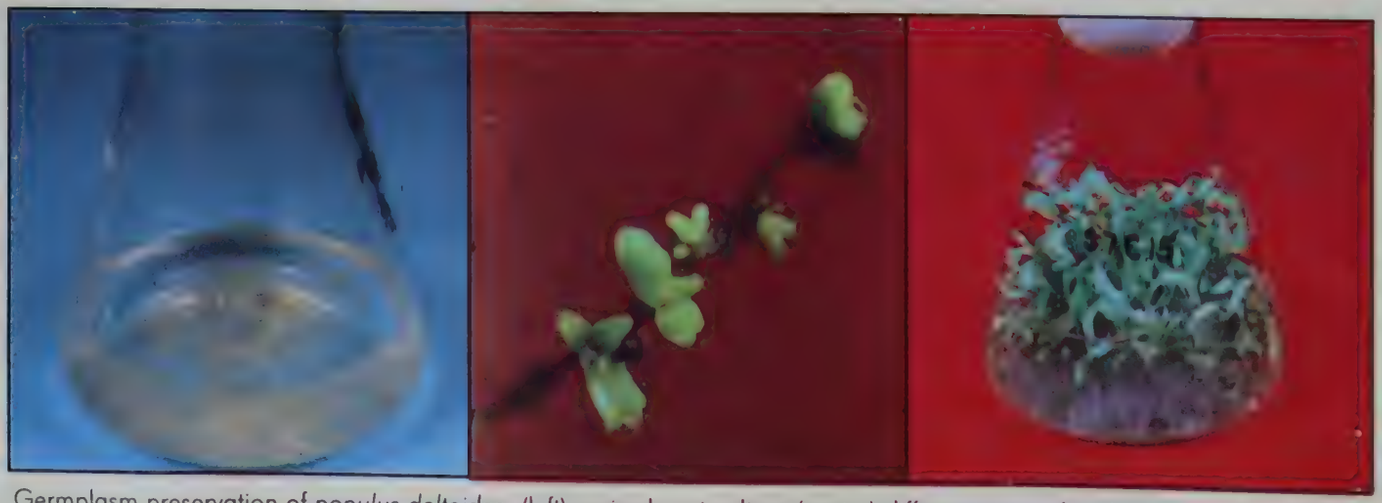
| | |
|---|---|
| FICCI Award for Surface Engineering Science (1996-97) | Rajagopa, Dr Indira (NAL) |

Biology & Biotechnology

*Hyoscyamus niger*-Aekla, (left) unbranched variety and (right) commercial cultivar

'Himalaya' the high oil yielding genotype of *Mentha arvensis*

Sandal wood for afforestation: growth and development of multiple shoots of *Santalum album L.*



Germplasm preservation of *populus deltoides:* (left) excised root culture (centre) differentiation of multiple shoot buds from a segment of the excised root (right) proliferation of root generated shoots on boro-silicate glass beads in place of agar.

CSIR's contributions to both basic and applied research were impressive. Noteworthy among these were IICB's studies on the understanding of basic disease processes especially leishmania and cholera, CIMAP's work on antibacterial activity of selected plant varieties and the work of several laboratories to enhance the economic value of plants through development of newer improved varieties and the agrotechnologies for their propagation.

## SCIENCE

### Mitochondrial import transfer of RNA in Leishmania

IICB in studying how highly negatively charged RNA molecule traverses two mitochondrial membranes against a membrane potential, observed that Leishmania mitochondria possesses a direct import mechanism for RNA involving membrane-bound receptors and positively charged import channels, distinct from co-import models according to which RNA-carrier complexes are inserted through protein import. As a result of this study, it has become clear that parasitic protozoa such as Leishmania has evolved a unique mechanism of mitochondrial tRNA import different from that used in yeast and higher plants. Further work on elucidation of the molecular details of the process may lead to efficient methods for gene delivery into mitochondria, which are difficult to transfer with exogenous DNA by conventional means.

### Mitochondrial DNA polymorphism for study of the Indian population

NCL carried out a study of 100 Indians from 14 language groups using mitochondrial DNA site polymorphism as a tool for generic variations. Twenty nine mitochondrial DNA haplotypes were identified and unweighted pair-group method (UPGMA) and maximum parsimony trees were constructed using the mitochondrial DNA types. Nucleotide diversity values were calculated using maximum likelihood method. From a study of the shared mitochondrial DNA types and the parsimony tree it was observed that the Indian population is closer to Caucasians and has an admixture with Asians. The north Indian population appears to have a recent admixture of the Caucasian mitochondrial DNA types which is absent in the south.

### Regulation of Interleukin-8 mediated biological response in human neutrophils

Interleukin-8(IL-7), a chemokine (C-X-C) is a neutrophil activating and chemotactic agent. The inflammatory cytokine acts on the target cells through a constitutively expressed cell surface receptor (20000/cell), and in many diseases like arthritis, inflammatory bowel an over expression of I1-8 sectors (C-X-C R1 and C-X-C R2) has been observed.

IICB studies for understanding the basis of differential expression of IL-8 receptor in inflammatory diseases using LPS, a bacterial cell surface molecule of gram negative bacteria was used as a immunomodulator. While LPS stimulated Ca2+dependent activation of the aminopeptidase it is seen that subsequent autoregulation of IL-8 receptor is a normal feature of healthy conditions. Since the aminopeptidase plays a critical 'house keeping role' in the regulation of the biological functions of the important proteins, it is possible that deficiency in the activity of the aminopeptidase may be the cause of long persistence of the receptor in upregulated state in pathological conditions facilitating interaction of more IL-8 and causing augmentation of the inflammatory diseases.

### Heat shock response

CCMB is attempting to understand how stress is sensed by cell/tissue leading to the synthesis of specific stress proteins. Using fluorescent probes that position differently in the plasma

membrane bilayer, it was observed that the composition of the plasma membrane changes within minutes of imposition of heat stress to the cell with a mild acidification of cytoplasmic pH. Using activators and inhibitors of kinases, CCMB could determine a role for protein kinase C in the interaction between the heat shock factor protein and the heat shock element, and thereby showed tyrosine phosphrylation to be involved in signal transduction during early stages of heat shock response. Studies to identify the particular kinase that specifically gets activated during heat shock are in progress.

### Chaperone-like activity of a lens protein

Molecular chaperones mediate the correct folding and assembly of several proteins in the cell. Understanding the molecular details of the chaperoning process is thus necessary to devise strategies to control several diseases and also to enhance the yield, solubility and stability of engineered proteins. CCMB is investigating the chaperone-like activity of the lens cortical protein α-crystallin. By using non-thermal aggregation mode, it was possible to discover the temperature dependence of the chaperone-like activity of α-crystallin. By studying the structural aspect of α-crystallin at different temperatures, and under different conditions, CCMα could identify quaternary and tertiary structural perturbations in the molecule, which lead to a concomitant increase in the hydrophobicity. Further studies using carbonic anhydrase, have shown that α-crystallin exerts its chaperone-like function by binding to the aggregation-prone molten globule state of the target protein.

### E.coli DNA T Protein

Conformational studies on E.coli DNA T protein by CBT suggest that the pathways of unfolding of thermal and urea induced transitions are different. $Mg^{++}$ affects the unfolding pattern and stabilises the secondary structure. These studies will facilitate development of suitable protocols for purification of recombinant proteins.

### Bacteriophage based detection of E-coli 0157:H7

E-coli strains that produce Shiga-like toxins (SLT) are important threats to human health. They typically do not produce glucuronidase (GUD) and so may go undetected by current E. coli tests based on hydrolysis of 4-methylumbelliferyl - B – D - glucuronide (MUG). E. coli 0157 has been recently implicated in the contaminated food in USA. The problem of monitoring of GUD negative, SLT-producing strains of E. coli from environmental sample could be overcome by means of a bacteriophage, specific to SLT-positive strains of E. coli, and carrying the gene encoding the bacterial GUD enzyme. An inducible lysogenic phage, JKB14, that carries the GUD gene and specifically infects E. coli 0157:H7 was isolated by NEERI. The unique reporter gene in bacteriophage JKB14 that encodes bacterial GUD enzyme together with appropriate specificity offers a rapid test for E. coli 0157:H7. The test is compatible with water monitoring based on presence-absence testing, without the need for additional equipment.

### Molecular mechanisms in fungal diseases

Fungal diseases are now emerging as a public health problem. Accordingly, CBT intensified its studies on molecular structure of major allergens/antigens of A.fumigatus and host pathogen interactions with respect to lung surfactant proteins. One of the immunodominant allergens was established as being cytotoxic ribonuclease with an IC(50) of 4.5 nM towards eukaryotic cell lines and specific ribonuclease activity of 100,000 units/mg of protein. The ribonuclease activity and cytotoxicity were destroyed by chemical modification of cystine and histidine residues. This allergen has structural homology with that of -sarcin and restrictocin

which are being considered for applications in chemotherapy of cancers. However, as these proteins are known to induce allergic reactions, the immuno-dominant cytotoxic allergen of A. fumigatus appears to be a better experimental candidate for application in chemotherapy after identification of functional domains.

## A novel anti-yeast compound of fungal source from Taxus sp.

CIMAP has successfully isolated from the Taxus tree, fungi capable of producing significantly high concentration of a potent diterpenoid. The new compound inhibited the growth of yeast strains *(Saccharomyces cerevisiae)* even at a very low concentration of 1 μg/disc. Some of the yeast strains carrying cell division cycle mutations were found to be highly sensitive to this compound. A fast screening procedure for the presence of the fungi in the sterile culture supernatant has been devised using yeast strains. It was seen that both taxol and the fungi were able to inhibit root initiation and elongation in a novel bioassay developed using *Bacopa monnieri* as a model system and were also able to inhibit oomycetous fungi *Pythium sp* and *Phytophthora sp*. These results are helpful to development programmes.

## Antibacterial activity of plant sources

- **Antibacterial activity of artemisenin related compounds and their mode of action :** recent studies at CIMAP have indicated that artemisinic acid inhibits gram positive bacteria such as *Bacillus subtilis. B. Thuringiensis* and gram negative pathogenic *Pseud-omonas aeruginosa* and *Salmonella typhimurium*. Stereo-specific differentiation of α and β isomers of arteether has been made possible using a nalidixic acid resistant strain of *Escherichia coli* which is sensitive only to α-isomer. α-Arteether resistant mutants of this strain isolated through chemically induced muta-genesis also reverted to nalidixic acid sensitive phenotype, suggesting the involvement of a modified form of DNA gyrase in *E. coli* $Nal^R$ strain in conferring the sensitivity to α-arteether. Also another *E. coli* supersensitive strain which is highly permeable to many antibacterial drugs has been found highly sensitive to all the artemisinin related compounds, suggesting that cell membrane permeability may also act as a barrier to the entry of drugs and provide sensitive phenotype. These observations will be of help to scientists for drug development, including the anti-malarial drug compound artemisinin or its derivative arteether.
- **Anti-bacterial activity of seeds of coprophilous plants :** CIMAP has observed that, the plants whose seeds can germinate and produce seedlings in the decomposing cattle dung possess antimicrobial compounds. Seeds of 40 such species of coprophilous plants were tested against saprophytic and pathogenic strains of bacteria for antibacterial activity against *Bacillus subtilis*, strains *Escherichia coli, Pseudomonas cichorii* and *Salmonella typhimurium*. Seeds of 36 species have been found to be active against at least one of the test bacteria while seeds of 16 species were found active against all the test bacterial strains. The seeds of the coprophilous plants were most frequently active against the plant pathogen *P. cichorii* (97%) followed by the saprophytic bacterium *B.* subtilis (83%) and animal/human pathogens *S. typhimurium* (69%) and *E. coli* (55%). Most of the tested seeds showed activity against both gram +ve *(B. subtilis)* and gram - ve *(E. Coli P. cichorii* and *S. typhimurium)* bacteria.
- **Anti-microbial activity in other plant varieties :** testing of 93 varieties of roses by CIMAP for antimicrobial activity indicated that some rose varieties contain different levels of antimicrobial factors in the petals against different strains of *Bacillus subtilis, Pseudo-monas aeru-ginosa* and *Escherichia coli*. Extracts from vetiver and *Albizia lebbeck* have been screened against twenty strains of pathogenic and non-pathogenic bacteria successfully. Aqueous seed extracts of crop plants like *Archis hypoqea, Solanum niqrum*

*Coccinea cordifolia, Lycoper-sicon esculentum* and *Physalia minima* have shown activity against *Salmonella typhi* and *Pseudomonas cichorii.*

### New Stomata discovered

Two special type of Stomata entirely new to the plant kingdom were identified by RRL, Jt. in *Catheranthus roseus.* These stomata are presently being named as Axillodicytic and Giant Axillodicytic respectively. Also two other stomata previously reported as one single individual have now been observed to be two distinct individual stomata and described as two distinct types. One is pole to pole contiguous with anomocytic arrangement of subsidiary cells and the other is pole to pole contiguous with paracytic arrangement of subsidiary cells.

### Molecular documentation of genetic diversity in medicinal and aromatic plants through DNA fingerprinting

Molecular markers are important for the authentication of the genotypes of released cultivars of plant species including medicinal and aromatic plants. They are also useful in assessing the genetic variability existing in the gene bank which can be used as a resource of useful genes in any varietal improvement programme. Studies conducted by CIMAP on medicinal and aromatic plants gave interesting findings. Randomly Amplified Polymorphic DNA (RAPD) profile studies of five cultivars of *Mentha arvensis,* indicated a relatedness of the Himalaya variety to Gomti and Kalka varieties which otherwise were having a greater genetic distance. This is suggestive of the probability of Gomti and Kalka being the donors of DNA in the development of Himalaya. Variety Himalaya has been released for commercial cultivation this year. Similarly, RAPD profiles of six different accessions of *Bacopa monnieri* collected from different parts of the country indicated a high level of genetic diversity. Absence of polymorphic variations was observed in one of the random primers (Primer-A, Lanes 1-6) which demonstrated species-specific monomorphic band.

### Toxicological implications of Glutathione depletion in neurotoxicity

Multidisciplinary studies conducted by ITRC showed that workers exposed to quinalphos at work environment were found to suffer from symptoms like alterations in higher functions of brain and motor system. Blood brain barrier is known to play an important role in protecting the brain from the toxic effects of many xenobiotics. Studies at ITRC indicate that exposure to quinalphos and cypermethrin in low doses increased the permeability of this barrier, enhancing chances of neurotoxicity. Quinalphos also altered the brain free radical generation and the enzymes involved in their scavenging. The cerebral proteins were found to be highly susceptible to oxidative damage and low levels of brain GSH enhanced the neurotoxic risks.

## TECHNOLOGY

### Commercially important tool for protein production by genetic engineering

CCMB has exploited the salt inducible proU promoter of *E. coli* for the construction of an expression strain in which it is possible to induce the production of a protein from a target gene by using common salt as the inducer. It is seen to perform better than the currently popular IPTG-inducible expression vector system, and to produce substantially lower amounts of the insoluble protein 'inclusion bodies', which promises to be a significant advantage in protein production. This salt-inducible expression vector system is to be shortly licensed to an overseas firm for commercial sales of this technology to researchers around the world.

## Universal polymer support for the synthesis of oligodeoxyribo and oligoribonucleotides

Solid phase synthesis of DNA and RNA requires at least eight different prederivatised polymer supports. The commercial availability of base labile synthons for DNA and RNA synthesis has necessitated the need to prepare a large number (50-60) of such pre-derivatised polymer supports making DNA and RNA synthesis a time consuming task. CBT has developed a versatile universal polymer support devoid of nucleotidic material and compatible to the existing methods of synthesis and deprotection of oligodeoxyribo and oligrobio-nucleotides. The universal support obviates the need to prepare a large number of prederivatised polymer supports. The development is being patented in India and USA.

## RNasin: inhibitor of ribonuclease

A constant problem facing an experimenter who handles nucleic acids is that of degradation of RNA by the uniquitously present enzyme ribo-nuclease (RNase). It becomes important to use inhibitors that abolish or greatly reduce RNase action. Such an inhibitor called RNasin is commercially available and extensively used. CCMB have developed an efficient method to isolate and prepare large quantities of RNasin in the pure form from discarded human placenta. This preparation was given to a commercial firm for market analysis and survey. The firm has now entered into an agreement with CCMB for commercial production of this molecular biological inhibitor found to be an excellent cost-competitive inhibitor.

## Bacterial consortium for waste management

CCMB has identified a series of mutants, which may help in the development of a consortium of bacteria that can degrade human refuse at low temperatures (4-15°C). CCMB in collaboration with DRDO has undertaken the development with a view to check pollution, for example, at outposts in the Himalayan border areas.

## Biomarker for the detection of minimal residual disease (MRD) in acute lymphoblastic leukaemia (ALL)

IICB have identified a unique biomarker on the leukemic blast cells in children. This biomarker serves as a reflection of circulating yet non-detectable leukemic blast cells i.e. for the detection of MRD. This assay developed is simple, sensitive and rapid method and can be performed with 2-3 ml of peripheral blood. The biomarker varies in different stages of the disease i.e. in the acute phase of the disease it is present in very high amounts, decreases with response to chemotherapy and interestingly reappears in relapse. This biomarker is not present in other blood disorders. It is obtained from the lectin, ATNh (i.e. Achatina fulica) snail, by single step purification with high yield (6%) coupled with restricted specificity and long term stability for over two years at 6-10°.

## Solid State Fermentation (SSF)

The concept of SSF has enormous potential especially for production of high value - low volume products, e.g. antibiotics, immunosuppressive and anti-cancer drugs. The technology has advantage on the environmental front. Extensive studies were carried out in RRL, Tvm for generation of data on the fundamental aspects of SSF and to develop microbial processes for production of value added products. A patent has been granted on the production of glucoamylase in SSF by Aspergillus niger. RRL, Tvm has also developed a bioreactor system for the production of fungal spores using SSF system and has filed a patent for the development.

### Production of free gluconic acid by a genetically altered organism

RRL, Jm has developed a fermentation process for the direct production of free gluconic acid from glucose using a genetically altered organism - a Tn5 transpogenised block mutant of *Gluconobacter oxydns.* The fermentation process has advantage over the known processes in generating the free gluconic acid in one step, without the requirement of *p*H control and at very low oxygen transfer rate.

### Invitro screening system for endocrine disorders

A yeast (Saccharomyces cerevisiae) strain useful in screening androgenic steroids has been constructed at IMTECH by integrating the E.coli B-galactosidase gene in the Ura3 locus. This screening system invovles function based screening of natural or synthetic compounds and thus has a potential advantage over the existing methods and is especially significant in steroid therapy system considering the recent use of androgens in AIDS patient to prevent wasting, besides their use in other clinical situations. This yeast strain could also be used in screening of mutations in the androgen receptor gene which impairs normal receptor function that has been implicated to be the cause for endocrine disorders and even prostate cancer. An easy, simple and function based detection system for such disorders is not available at present.

### Cytoplasmic male sterility (CMS) through RAPD analysis

Molecular understanding of CMS is useful in selecting potential maintainers and restorers by the study of their cytoplasms at an early stage. This knowledge can be of immense help to seed industry. NBRI conducted RAPD analysis of mitochondrial and total genomic DNA in different lines of rice and sorghum to understand molecular basis of CMS and restoration of fertility in these breeder's lines. Primers were identified that grouped the sorghum restorer lines according to their restoration characteristics. In rice, two distinct groups of cytoplasms which could be further divided into sub-groups were identified. The RAPD technique was also applied to identify accessions in neem (*Azadirachta indica*) to generate information on DNA heterogeneity that will be useful in identification and management of biodiversity in neem.

### Macropropagation of difficult to root species in protected environments

Macro-propagation plays a significant role in rapid multiplication of selected mother plants or elite genotypes. NBRI has taken up the study to standardise macro-propagation techniques in difficult-to-root species and to clone desirable and promising genotypes of value added Multi Purpose Tree Species in controlled environment. Techniques have been developed to achieve profuse rooting in several agro forestry species (neem and *Casuarina)* and horticultural species. Nearly 100% rooting was achieved in `Aonla' (*Emblica officinalis*) and guava (*Psidium guavja*). Conventional growth hormones for stimulating the rooting induction were dispensed with. External factors of temperature, humidity, moisture potting mixture etc. were standardised for optimum rooting induction.

### Genetically improved planting stocks for afforestation on degraded soil

Availability of site-specific quality germplasm is essential for successful afforestation especially in degraded soil sites. If germplasm used has a narrow and unidentified genetic base, it results in serious losses or complete failure of planting. Studies were conducted at NBRI to develop genetically improved planting materials for afforestation of sodic soil sites through selection and silvicultural practices. Seed stands of four species, viz., *Acacia nilotica, Prosopis*

*juliflora, Albizia procera* and *Terminalia arjuna* have been established for obtaining improved seeds. Inter- and intra-specific variations in species like *Prosopis* and *Acacia* were studied in provenance and species trials. Candidate and plus trees of *Prosopis juliflora* were identified and included in field trial for genetic testing and elite tree selections. Field trials on selected planting material developed at NBRI showed good adaptability, growth rate and biomass yield per unit area.

## Biosensor for monitoring of pesticides residues

In collaboration with the Visva Bharati University, NEERI has taken-up the development of biosensor for detection and estimation of organophosphorous pesticide residues in natural waters. The easy to use biosensor provides real-time data on measurements of trace concentrations of organophosphorus pesticide residues in water under real life conditions. The enzyme has been immobilized using covalent crosslinking with Bovine serum albumin (BSA) and glutaraldehyde. Desirable stability, consistency, reproducibility, maximum retention of enzyme activity, and its application on electrode for potentiometric detection have been achieved. Environmental conditions such as pH, temperature, substrate concentration, pesticide concentration and enzyme-pesticide contact time have been optimized for the sensor. The enzyme sensor can be regenerated for reuse after inhibition with a dilute solution of 2-PAM (2-pyridine aldoxime methiodide).

## High yielding menthol mint variety - Himalaya

Himalaya, a promising genotype of *Mentha arvensis*, developed by CIMAP through cross pollination of Gomti and Kalka varieties (also developed by CIMAP earlier) has been released for commercial cultivation this year. Himalaya combines the high regenerability and oil yielding ability of Gomti and disease resistance properties of Kalka. Himalaya has proved significantly superior to the parent varieties and also to a local cultivar Shivalik in terms of oil yield and menthol content in multi year and multi locational trials. It is also free from all common diseases. The variety is currently cultivated in farmer's field and adopted under the Ambedkar Vishesh Rojgar Yojna of Uttar Pradesh Government. This particular project aims to create 425 direct and 2550 indirect job opportunities within two years.

## Improvement of Jamrasa through tissue culture

Geraniol, the principal constituent of Jamrasa oil finds good use in perfumery, pharmaceuticals, soap and cosmetic industries. Jamrasa is ideally suited for revegetation of waste land by virtue of its ability to grow under adverse soil and climatic conditions. A method for high frequency regeneration of Jamrasa from callus has been developed at RRL, Bhu. The field evaluation of tissue cultured clones has been carried out and recently two improved clones have been developed with 0.8%-0.9% essential oil content as compared to 0.4-0.5% essential oil content in normal Jamrasa varieties.

## Microrhizome inductioners of turmeric

The conventional method of propagation of turmeric through pieces of the underground rhizome is very slow with rhizome producing 5-6 plants in a year. Moreover these are susceptible to diseases like leaf spot and rhizome rot. RRL, Bhu has standardised protocols for tissue cultured propagation of turmeric through in vitro induction of microrhizome. In vitro microrhizomes are free from rhizome grown pathogens and can be used as disease free seed rhizomes, and would facilitate intercontinental germplasm exchange.

### Pest resistant transgenic cotton varieties

NBRI had earlier employed genes coding for δ-endotoxin and cowpea protease inhibitor proteins that are inhibitory to insect growth. This has now been successfully employed for the complete synthesis of about 2000 bp double stranded DNA fragment encoding a δ-endotoxin protein to develop transgenic cultivars of Indian cotton varieties resistant to bollworms - the major insect pests of cotton. The gene was synthesised in four parts by assembling 8 to 28 oligonucleotides in a single reaction followed by efficient and error-free ligation, thereby establishing the possibility of designing the sequence of a desired gene and its chemical synthesis and assembly. NBRI also established an efficient protocol for direct organogenesis via multiple shoot induction for 13 different cultivars of G. *hirsutum* and *arboreum* species of cotton to give 10 to 15 shoots/explants in a single step. This provides a new explant for direct gene transfer in cotton by microprojectile and *Agrobacterium*.

### Improved clonal variety of lemongrass

Lemongrass oil is one of the major essential oils produced in India, for its use in cosmetic, perfumery and pharmaceutical industries and is very highly priced in the international market. An inter -culture partner of perennial plantations like *Eucalyptus* and Poplar lemongrass is known to increase soil fertility. CIMAP has recently developed a high oil and citral yielding lemongrass variety Krishna as a result of recurrent selection programmes. Krishna exhibits a potential to yield 200-240 kg oil/ha and has relatively higher oil content (average 1.5% and a recovery of 0.8 to 1.0% in large scale distillation compared to the traditional varieties. The citral content in its oil ranges between 82-86%. Commercial exploitation of this variety will help India regain its status as a prominent exporter of lemongrass oil. Lemongrass is also recommended for wasteland cultivations.

### Aekla - an unbranched variety of Indian henbane (Hyoscyamus niger)

CIMAP has released a superior variety of Indian henbane *(Hyoscyamus niger)* a rich source of tropane alkaloids - hyoscyamine and hyoscine which have sedative, mydriatic, antispasmoidc and anticholinergic properties. In contrast to the normal plant type including that of var. Aekla the new variety Aekla is unique because of the most remarkable quantitative changes for a majority of plant traits. It is unbranched, erect and tall with marginally arranged (non-over lapping) larger and thick leaves with pedicillate and andro-or apetalous flowers containing 7-9 bold and dark purple anthers. Being about three times richer in crude drug content, var. Aekla has the genetic potential of yielding 4-5 times more tropane alkaloids per unit area and input over the local bulk and nearly twice the earlier released variety Aekla. Commercial cultivation of Aekla will help meeting domestic requirement of the alkaloids hyoscyamine and hyoscine while simultaneously providing better returns for its cultivation in terms of improvements in herbage yield.

### Elite clones of plants through tissue culture

Mass multiplication of stress tolerant plants of Neem (*Azardirachta indica)* known for its medicinal and biopesticidal properties, and Pomegranate (*Punica granatum)*, a hardy fruit tree and sandalwood *(Santalum album)* with high commercial value, through tissue culture has been initiated at NEERI to enable faster rejuvenation of wastelands, mine spoil dumps and degraded forests with economically and ecologically important tree species. The process of hardening was achieved by maintaining the plantlets at high relative humidity and covering the plantelets with perforated polythene bags, and thereafter transferring to soil media and gradually acclimatising to natural conditions. The hardened plantelets of neem and

pomegranate have been transferred to the natural soil ecosystem on the Institute's premises, and on manganese mine spoil dump at Gumgaon, near Nagpur. The regenerated plants show multiple branching, and an increase in plant height. Their protein and chlorophyll contents are comparable with the naturally grown mother-plants. Sandalwood plantlets regeneration has been standardised to generate material suitable for stressed conditions on the dumps.

### Domestication of *Valeriana jatamansi* (Muskbala) in mid hills

The *Muskbala* plant is used for perfumery industry and for making incense items and rhizomes of the plants are traditionally used for treating hysteria and urinary problems. The plant has been domesticated and about 3000 plants are growing in an area of 0.25 acre at the IHBT farm. Commercial cultivation of this plant is being popularised.

### New tea propagation technology

Conventional tea is propagated by single node cuttings. IHBT has succeeded in propagation 4/8 node cuttings. The cut ends of four and eight node cuttings were treated with different auxins and phenols resulting in 85-90% success in rooting and transfer to field within 9 months. Thus it is possible to obtain healthy plants within 9 months as compared to conventional methods where it takes nearly 2 years.

### Germplasm preservation of *populus deltoides* through excised root culture

Successful experimentation on *P. deltoides* at NBRI, has established, for the first time, the possibility of germplasm preservation/conservation through excised root culture of heterozygous tree species and identification of the tissue of root explant involved in the regenerant differentiation. The innovative process developed has immense importance for establishing germplasm repository of different genotypes, even exotic ones, for afforestation, production of woody biomass for energy as well as for paper and cottage match industry. Outstanding advantages of the process include simple incubation conditions moderate temperatures (25 to 35°C), unaffected by temperature fluctuations, no light requirement, low maintenance cost, long intervals between subcultures which can be extended to even six months or more, economy of space as several metres long root can be accommodated in small containers and production of a large number of progagules from small segments of roots. These attributes also make the system very useful to promote safe exchange of germplasm over long distances unaffected by lack of light and temperature fluctuations during transit.

### Mericloning of citrus

A breakthrough in propagation of citrus fruit plants has been achieved at NBRI. Meristem culture for propagation of citrus plants is a sure way of obtaining specific pathogen (particularly viruses) free plants and is a welcome alternative to the present globally adopted micrografting technique, which is most arduous and time consuming. The breakthrough achieved has been in successfully growing 1-mm-long shoot meristem, excised from field-grown trees of two commercially important citrus species, viz., *C. aurantifolia* and *C. sinensis* by an in vitro strategy and regenerating the shoot meristems by growing them sequentially in a liquid medium of a particular composition followed by their culture on an agarified medium supplemented with different concentrations of growth substances after they picked up growth to certain length. Such regenerated shoots could either be rooted giving rise to individual plantlets or proliferated into enormous number of cloned shoots of the same genetic make-up as that of the mother plant, constituting an invaluable and renewable source of pathogen-free scion material for grafting.

### Desert economic plants

The earlier initiated work at CSMCRI on field verificatory trial on tissue culture raised seedlings of *Salvadora persica* were successfully completed. The performance of micropropagated seedling was found to be better than seed raised seedlings. The laboratory now developed the protocols for micropropagations of *Suaeda nudiflora* and Jojoba *(Simmondsia Chinensis)* for utilisation of saline and non-saline wastelands leading to ecology upgradations combined with economic benefits. Assessment of biomass of halophytes along the South and West Coast of the country was undertaken and available germplasm was collected and conserved. Also protocols for storage of halophyte seeds without loosing viability for long periods of 2-3 years were developed. The species of plants worked upon can in the long run lead to sustained income by using currently unproductive land.

### Distillation waste of aromatic grasses as medium for mushroom cultivation

Currently rice straw (or thatch) is used as a stuffing medium to grow edible mushroom indoors. CIMAP has discovered that distillation waste of aromatic grasses can be used as the growing medium of edible mushroom of *Pleurotus* sp., thus sparing rice staw for its other important uses as cattle fed, roofing of huts etc. Besides it enables mushroom cultivation as a profitable diversification for growers and distillers of aromatic grasses. The distillation waste being available cheaply, the cottage industry would gain substantially from this novel findings.

## SERVICES

### Sheath rot and banded leaf spot - a new disease in citronella Java

More recently, the commercial cultivation of citronella Java in Terai region of Uttar Pradesh has been reported to be under the grip of a severe banded leaf spot and sheath rot disease. This is in contrast to other diseases recorded so far in this crop. The disease is particularly damaging during monsoon in poorly drained fields and the infected plants completely succumb to disease without any recovery. Experiments conducted by CIMAP involving repeated isolation of the fungus have enabled identification of the fungus *Rhizoctonia solani* Kuhn responsible for the disease. These findings serve as the first report of *R. solani* causing banded leaf spot and sheath rot in citronella.

### Oligonucleotide synthesis

An oligonucleotide synthesis facility has been established at NCL and high purity oligonucleotides are being supplied to many hospitals and research laboratories for use in DNA diagnostics. Several scientists and students have been trained in synthesis of oligonucleotides in the facility, which also offers courses for M.Sc. (Biotech.), Pune University. This is one of the very few facilities in the country capable of providing custom synthesis oligonucleotides including the chemically modified ones.

### Hepatitis B Vaccine

A small biotechnology firm, which had the technology for laboratory scale production of the hepatitis B viral antigen through genetic engineering, approached CCMB for technical advice and help in optimizing the protocol and for large scale production of the vaccine. Based on technical advice and consultancy provided by CCMB the firm was able to produce the material and sent it through clinical trials with success. The company has now launched the hepatitis B vaccine in the market.

### Pesticide residue tests for tea

Testing facilities for pesticide residues in tea has been established at IHBT. One hundred thirty test samples of prepared tea collected from markets and different factories were tested and most of them were found free from pesticide residues. The data was generated for the pesticide residues of Endosulfan, Monocrotophos and Ethion on tea to recommend the quantity of pesticide application and also the waiting period of standard plucking.

### International Legume Database Information Service (ILDIS)

NBRI is the Regional enquiry Centre of South Asia of the global enterprise ILDIS. It has developed computerised database of legumes of eight South Asian countries viz India, Nepal, Bangladesh, Bhutan, Pakistan, Myanmar, Sri Lanka and Maldives in collaboration with RBG, Kew, U.K. The database, the first of its kind in South Asia is uniquely authoritative and covers taxonomically integrated species diversity of 1948 legumes including all economically important legumes. The database contains information on accepted name, synonyms, life form, conservation status, geography, literature, description, illustration, notes and bibliography for all the 1948 species of the eight countries. The Phase I database has been made ready for inter linking data on Phase II database on economic use, ecology and images of legumes. The Phase I datasets of immense use to biodiversity conservation are ready for use by any institution world over. The database is being put on internet to facilitate its global access. It will also help in comparing the inventories from other parts of world.

### Installation of rose oil distillation unit

CIMAP commissioned a 150kg capacity rose oil field distillation unit at Pushkar in Rajasthan for M/s Ravina Agrochem Pvt. Ltd., Bombay. Necessary training on economic extraction of rose water and rose oil was also provided to the party. The unit will help damask rose growers to extract quality oil of comparable standard and will attract more such projects and farmers/entrepreneurs.

## HUMAN RESOURCES DEVELOPMENT

### National workshop-cum-training on herbal drugs

RRL, Jm hosted a National workshop-cum-training programme on 'Quality Control & Standardisation of Herbal Drugs' organised by ICMR Centre for Advanced Research during March, 1997. Around 30 participants from Ayurvedic Research Institutions and Industry attended.

### Training-cum-demonstration programmes for propagation of aromatic and medicinal plants

CIMAP organised eight training-cum-demonstration programmes throughout the country in collaboration with Small Industries Development Bank of India (SIDBI), Spice Board (SB) and Uttar Pradesh State Horticultural Co-operative Marketing Federation on various aspects of cultivation, processing and marketing of medicinal and aromatic plants and plant products. A total of 223 representatives from farming and small and large scale industry sectors were trained.

### Workshop on cultivation and processing of medicinal and aromatic plants in UP hills

CIMAP organised a two day workshop on cultivation, processing and market potential of medicinal and aromatic plants and related March, 1997 at Almora, with financial support

from Small Industries Development Corporation (Hills). The workshop was attended by 125 participants who were exposed to the cultivation, distillation and market strategies for important crops like rose. CIMAP is hopeful of introducing its damask rose cultivar 'Noorjahan' in the UP Hills parallel to Kashmir Hills.

### Training in micropropagation techniques

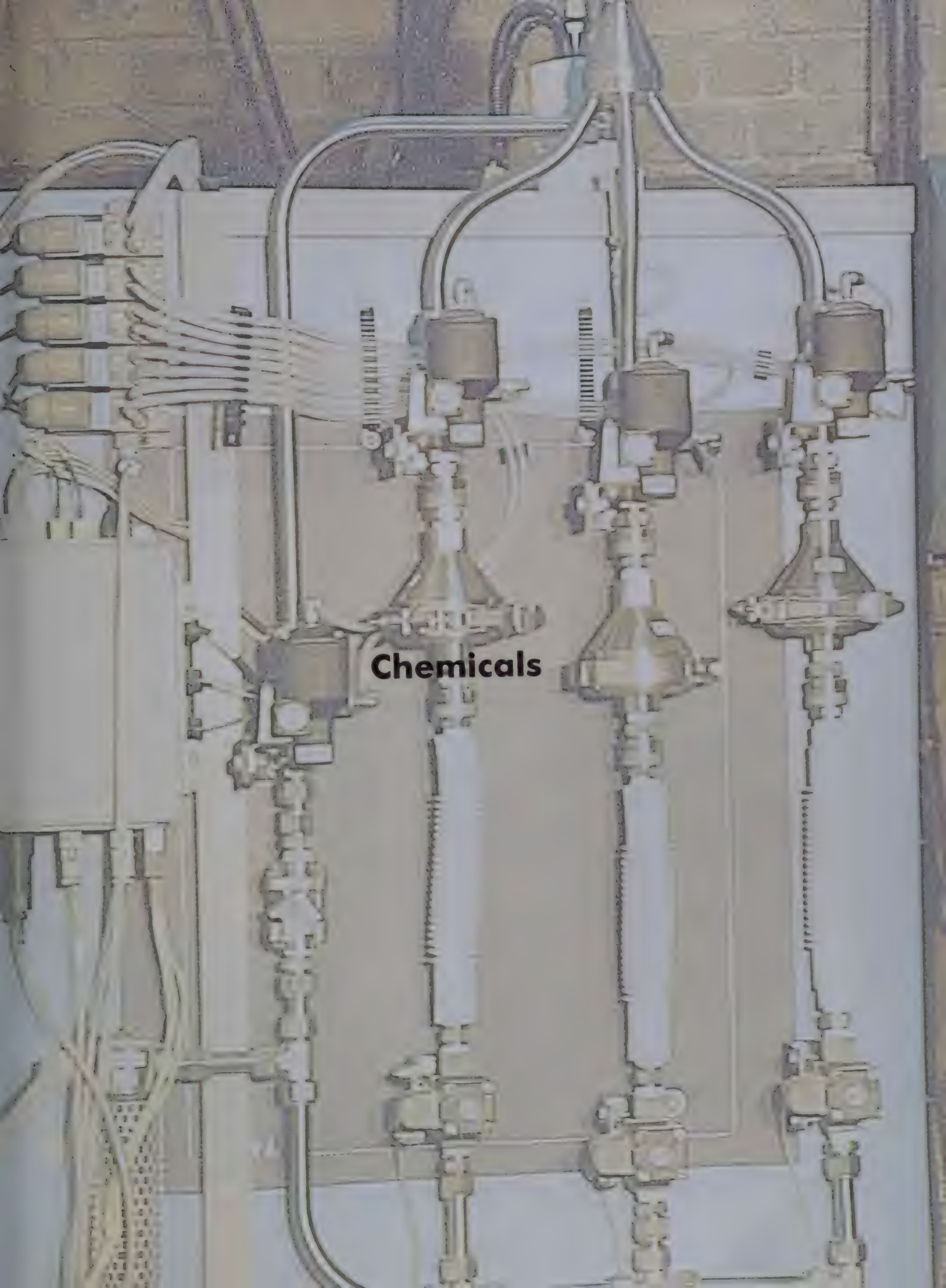
A three week training programme on 'Basic and Applied Techniques in Micropropagation Industry - A Practical Course' was conducted for industry personal at IHBT. Emphasis was given to practical protocols in micropropagation, tissue and protoplast culture, mycorhiza in biological hardening of plants, virus indexing and basic aspects of plant physiology.

### Training in taxonomy and molecular biology of actinomycetes

Actinomycetes bacteria have important usage in pharmaceutical and other biotech industry as many of them are precursors to useful antibiotics. Only a limited expertise is available in India for this group of micro-organisms. A short-term training course on 'Taxonomy and Molecular Biology of Actinomycetes' aimed at familiarising researchers with the modern techniques of characterisation and manipulation was organised by IMTECH from September 30 to October 12, 1996. It was attended by a total of 17 participants of which 8 were from industry.

## RECOGNITION & AWARDS

| | |
|---|---|
| Fellow of the India Botanical Society | Akhtar Haseeb, Dr (CIMAP) |
| Fellow of the American Association for the Advancement of Science, Washington, USA and 10th Kharazmi International Festival Award IROST, Iran | Balasubramanian, Prof D, (CCMB) |
| CSIR Young Scientist Award for Biological Sciences (1996) | Bhakuni, Dr Vinod (CDRI) |
| Fellow, Indian National Science | Chatterji, Dr DAcademy (CCMB) (FNA) |
| Raman Research Fellowship, CSIR | Chattopadhyay, Dr Amitabha (CCMB) |
| Raman Research Fellowship, CSIR | Gowrishankar, Dr J (CCMB) |
| INSA Young Scientist Award (1996) | Raman, Shri B (CCMB) |
| Fellow, Collegium Internationale Neurophama-cologicum (CINP) | Seth, Dr PK (ITRC) |
| Hari Om Ashram Trust Award for Research in Life Sciences | Singh, Dr Lalji (CCMB) |
| Fellow National Academy of Sciences of India (FNASc) | Sinha, Dr Somdatta (CCMB) |
| Shanti Swarup Bhatnagar Prize in Biological Sciences (1996) | Swarup, Dr Ghanshyam (CCMB) |



# Chemicals

Pilot plant at IIP for desulphurisation of flue gases

Secondary brine purification system of the membrane cell plant for production of caustic soda and chlorine (inset) a view of the membrane cell demonstration plant at CECRI.

CSIR laboratories contributed to science that is the harbinger of technology development especially for protein synthesis, catalysts and polymers. Significant processes were developed for several petrochemicals of value to industry besides undertaking contract R&D for some of the well known Indian and foreign clients.

## SCIENCE

### Molecular organization in hydrotope assemblies

Transnational cooperation in research has enabled a team of scientists from CCMB, IICT, University of Syden (Australia), University of Canerbury (New Zealand) and Clark University (USA) to throw new light on molecular organizations in hydrotope assemblies. Findings show that these compounds form open layer assemblies reminiscent of lamellar liquid crystals.

### Novel method of probing biocatalysts

A novel method of probing the vicinity of biocatalysts compartmentalized in the water pool of cationic reversed micelles has been developed at IICT. The catalytic efficiences of reversed micellar water-pool encapsulated enzymes are expected to depend on the local molar concentrations of water and other ions in the water-pool. Deciphering such local concentrations of water and other species present deep inside the reversed micellar water-pool is a daunting challenge. Using a phenyl cation trapping technique, IICT has devised a probe for measurement of concentrations of water and counterion in the water-pool of a cationic reversed micellar system across a range of solution compositions. IICT's results strongly indicate that the catalytic activities of enzymes compartmentalized in the water-pool correlate sensibly with the local molar concentrations of water and counterions.

### A new method for isothermal phase equilibrium studies

IICT has developed and tested, for the first time, a simple and accurate method for isothermal phase equilibrium studies. The method involves the experimental determination of the infinite dilution activity coefficient of each component of the binary mixture by means of gas chromatography. Subsequently, the activity coefficients are used for the calculation of isothermal phase equilibria. In the first phase, work on ten binary mixtures containing an aliphatic alcohol as one component and aromatic hydrocarbon as the other has been carried out. Results on four systems, for which data measured by the conventional methods for VLE are available, were in good agreement with the literature values.

### Experimental probe for investigations on 2-D crystallisation

Organisation of molecules into structural clusters is a fundamental step in any crystallisation process. The study of amphiphilic molecules in 2-D crystalline clusters on aqueous subphases at CLRI has led to simple models for iomineralisation preparation on semiconducting nanoparticles and new materials for cloud seeding.

The work of CLRI is the first of its kind in which the polymer is bound solely by the end groups. When such a polymer is tethered to a nonsolvent, it forms a distinct phase and exhibits a characteristic shape with the formation of an insoluble monolayer at the liquid/gas interface. It opens up a new thermodynamic approach in which the polymer while being regarded as a continuous layer of uniform thickness, is assumed to be totally free of solvent interplay. All the contributions to the free energy change of the surface of the liquid due to the polymer is postulated to be additive.

It is thus now possible to predict the general spreading and wetting behaviour of these polymers on gas/liquid and solid/liquid interfaces using the model besides new possibilities in designing controlled wetting of surfaces, regulated coating of substrates etc.

### One-pot synthesis of heterocyclic β-chlorovinyl aldehydes

Heterocyclic compound such as 3-chloro-1-H-pyrrole-2,4,-dicarboxaldehyde have biocide potential for applications in leather, agriculture and allied industries. These were synthesised for the first time at CLRI by 'One-pot-synthesis'. This novel synthetic route for heterocyclic compounds does away with multistep synthetic route (involving several reactants for each step) adopted by other reserachers.

### Protein folding and self assembly

Presently, there is no representative model to probe the intriguing phenomenon of 'Protein folding and self-assembly'. CLRI has synthesised a novel nonionic peptide model for this study. The unique feature of this work relates to the correlation between the thermodynamics of self-assembly of peptide and molecular parameters like conformational preference. The interplay of entropy-enthalpy compensation on overall self-assembly has also been clearly brought out.

### Chemical modification of electrodes through self-assembly approach

Modification of metallic surfaces with self-assembled monolayers (SAM) of organo-sulfur compounds has potential applications in a variety of areas such as electrodes kinetics, electrocatalysis, electro-analysis, molecular recognition, sensors, adhesion and non-linear optics.

Researches carried out at CECRI, have shown that self-assembly approach could facilitate incorporation of monolayers of reversible hexacyanoferrate redox species on gold electrode that exhibits good electrocatalytic effect on the oxidation of ascorbic acid and hydrazine. Also monolayers of reversible nickel hydroxide moieties could be immobilised on gold surface which showed electrocatalytic influence on the oxidation of glucose. The studies, aim at the development of modified electrodes with functional characteristics in the design of electrocatalysts and novel sensors for molecular recognition.

### EMI and conducting polymers

Whilst conventional plastic materials are excellent electrical insulators having resistivities in the range $10^{15}$-$10^{18}$ n.cm, some electronic applications require them to be conducting. In order to impart conductiveness to these plastics conducting fillers are generally added. CECRI has worked on grafting of conducting polymer like polypyrobe / polyaniline on a Eglass fabric surface resistivity of 1 to 10 Ohm cm. These grafted fabrics are used for making conducting FRP with surface resistivity 2 Ohm cm. The shielding effectiveness obtained is 90dB upto 1MHz.

### Hydrotropes - a class of self-assembling molecules

Though amphiphilic in character hydrotropes have shorter hydrophobic regions and thus differ from classical surfactants and yet they display substantial (and often selective) ability to solubilize lipophilic compounds in water. Beyond the minimal hydrotropic concentration, these molecules self-aggregate to produce the operating assembly. Studies at CCMB based

on crystal structure analysis of several hydrotropes have shown that these compounds form open-layer assemblies (reminiscent of lamellar liquid crystals), consisting of alternating hydrophobic clustering of the nonpolar regions adjacent to ionic or polar regions that are knitted together in a two-dimensional network. Stacking of aromatic rings is not seen. Two types of assemblies are seen, one with a more open and extended hydrophobic layer than the other. Solubilizates enter the hydrophobic layers of microunits producing a cooperative and mutual stabilizing effect. The observed open layer structure of hydrotropes might also account for the occasional ability of these compounds to solubilize even better than micelles.

## Photoinduced electron transfer processes

Photoinduced electron transfer is crucial to a number of natural and technological processes, such as photosynthesis, artificial solar energy conversion and photoimaging. RRL, Tvm has been studying the photogeneration of highly reactive radical ion intermediates, as well as the use of liquid/liquid interphases as methods of controlling backelectron transfer associated with these processes which invariably limit their efficiencies.

The radicals generated in such processes have been utilized in a variety of inter and intramolecular carbon-carbon bond forming reactions for the synthesis of various lactams, chromans and chromanones. Efforts have also been made to synthesize among others new pyrilium based sensitizers to increase the efficiency of photoinduced electron transfer process. Various electron donor-acceptor substituted butadiene derivatives with a view of developing new organic molecules capable of second harmonic generation.

These studies are important in the development of new synthetic methodologies for carbon-carbon bound formation, new materials for electro-optic applications and technology for photoremediation for industrial waste water.

## The itinerant extraction behaviour of Yitrium

The ligand dependent properties of yitrium have been recently exploited for the preparation of high purity yitrium oxide by liquid-liquid extraction. In view of this, the anamolous behaviour of yitrium was investigated from aqueous solutions containing soft and hard ligands using octyl-(phenyl)-N,N disobutyl-carbamolyl-methyl phosphine oxide (CMPO) as an extractant. Based on the study of the itinerant behaviour of yitrium, RRL, Tvm has proposed a scheme for the separation of yitrium from heavy rare earths in fewer stages of counter current extraction from xenotime mineral.

This work highlights the possible separation of Y from other lanthanides in xenotime samples using CMPO as extractant in few stages than commercial extractants like di-2-ethyl hexyl phosphoric acid and PC88. The separation factor obtained for Lu/Y is 3 times higher with CMPO than di-2-ethylhexyl phosphoric acid, a well known commercial extractant.

## Multifunctional detergent dispersants / antioxidants for long life lubricants

It has become imperative to conserve lubricants by enhancing their performance levels through energy efficient utilisation and extending the useful service life in gasoline and diesel engines by extending drain intervals. These require use of new classes of additives which in addition to antiwear characteristics of traditional additives also enhance sludge solubilisation, reduce viscosity increase of the oil in service and essentially inhibit formation of deposits in engine due to ash containing detergents.

IIP has attempted R&D aimed at synthesising completly ashless mannich bases and alkyl salicylates from naturally occurring environmental friendly alkyl phenols which have all these desirable properties. Long chain alkyl salicylic acids have been synthesised and mannich bases with certain hindered amines are under preparation. These additives will be specially useful for new class of biodegradable high performance lubricants.

### Thermally stable and catalytically active superacid zirconia catalysts

Iso-butane is important for its use in the preparation of MTBE (methyl tertiary butyl ether) and iso-octane, the environmentally accepted octane boosters. Also, the nitration of halobenzenes especailly chloro benzene to nitrochlorobenzene is industrially important because of the useful derivatives for pharmaceuticals, intermediates for dyes and agricultural chemicals etc.

RRL, Bhu successfully synthesised and characterised thermally stable and catalytically active superacid zirconia catalysts to effectively catalyse the isomerization of n-butane to iso-butane and nitration of halobenzenes. The superacid sulphate doped zirconia has been prepared by two different routes i.e., percolation followed by decantation and controlled sulphur impregnation method. The material has been characterized using various modern techniques to ascertain its crystal phase, thermal stability and active centres.

### Transition metal oxide pillared montmorillnite

Iron oxide, chromium oxide and ironchromium mixed oxide, pillared materials can be used as eco-friendly para-selective catalyst for nitration of halobenzene, which is an important commercial reaction. For the first time RRL, Bhu has reported the preparation of two new pillared materials viz., manganese and iron chromium mixed oxide pillared montmorillnite useful as industrial catalysts. All the materials calcined at 500°C are useful as hydrocarbon dehydrogenation catalyst.

### Organic additives for energy efficient zinc production processes

Almost 8% of zinc production in the world is through roast sulphuric acid leach electrowinning process and the high energy consumption during electrolysis has emerged as the most significant cost component. Studies at RRL, Bhu has shown that some organic additives are suitable for reducing energy consumption during electrodeposition of zinc at the laboratory scale. Applicability of these organic additives for industrial production of zinc is to be tested at the bench and pilot scale levels for confirmation of results.

### Zeolite and clay based adsorbents and catalysts

Zeolite clays and metal complexes incorporated porous materials are being increasingly used as adsorbents and catalysts for developing ecofriendly and economical processes. CSMCRI has taken-up the development of zeolites and clay based catalysts/adsorbents for specific applications, alkylation of benzene, dehydration of cyclohexanol to dicyclohexyl ether and hydrogenation of aromatics.

Also the possibility of using organo-clays for removing dyes from the effluent was studied along with other methods/adsorbents such as hypochlorite, hydrogen peroxide, zeolite-Y, zeolite-13X etc. The organoclay was found to be more effective for decolorization of effluents. Meso porous silica and alumino-silicate using different templating agents having surface

area of 900 $m^2$/gm was prepared and is being used for encapsulation of complexes for producing catalytic systems.

### Inorganic performance complexes

Understanding the role of bridging ligand is necessary to design molecular wire and non-linear optical material. The mononuclear photo/redox complexes have potential for application in catalysis.

A series of redox active mixed valence binuclear (donor-acceptor) metal complexes were synthesised at CSMCRI with an objective to investigate the role of bridging ligand in tuning the metal-metal interaction and photoinduced electron transfer process. Further with the aim to develop photo/redox active transfer metal complex a series of mononuclear Rh (III) and Rh(II) complexes have been synthesized which show excellent catalytic activity towards electrocatalytic reduction of $CO_2$ to formic acid.

### Inorganic co-ordination polymers for designing microporous materials

Metal complexes with polymeric networks and self assemblies have attracted special attention in recent times for application in catalysis, separation technologies, as new magnetic materials and transition metal liquid crystalline materials. Designing new inorganic co-ordination polymers have been initiated at CSMCRI. Different structural frameworks have been generated with metal centers being Co(II), Cu(II) and the organic moieties being dicarboxylates of varying chain lengths and N-donor ligands.

The complexes synthesised have been characterised by various physico-chemical techniques and single crystal X-ray studies. The versatile co-ordination of dicarboxylates coupled with conformational flexibility and manipulation by various N-donor ligands has created interesting polymeric networks with cavities. The catalytic and molecular sieving activities of these are being studied.

## TECHNOLOGY

### Poly alpha-olefin

Poly alpha olefins, used as lube oil stocks are synthesised by oligomerizing higher alpha-olefins such as 1-octene or 1-decene using catalytic systems based on boron trifluoride, which is hazardous and environmentally unfriendly. A novel approach using a supported Lewis acid catalytic system based on aluminium alkyls is being developed by NCL for the oligomerization of higher alpha-olefins to suitable lube oil compositions. Reaction parameters have been standardised to obtain oligomers with required specifications at 500 ML/batch scale.

### 4-Chloro aniline

4-chloro aniline is an industrially important organic chemical which finds exclusive use in dye-industry and for preparation of agrochemicals. Hydrogenation of 4-chloro nitrobenzene results in removal of the chlorine from the aromatic ring. To overcome this problem a convenient synthesis of 4-chloro aniline and some other substituted amines was developed by RRL, Jt using corresponding phenols as the starting material.

### Pesticides from Annona squamosa

IICT has extracted two new compounds, Isobullatacin and Isoquamocin from *Annona Squamosa* (custard apple) seed and studied their insecticidal activities. Bioefficacy studies on the formulated products have been encouraging with respect to larval survival rate. Field trials on tomato crops have given higher yield as compared to traditional pesticides. The products have great potential as environmentally friendly insecticides for agricultural practices the world over.

### Solid acids for nitrations and esterifications

Innovative design of solid acids as catalysts for ecofriendly processing of aromatics has been attempted by IICT. The laboratory has for the first time successfully achieved nitration of aromatics with a solid acid catalyst with consistent activity at room temperature. Solid acid catalysts developed by the institute also provide cheaper options for esterification of chemicals used in fragrance industry.

### Membrane cell technology for the production of caustic soda and chlorine

CECRI has developed a 2 tonnes per day bipolar membrane electrolyser consisting of titanium anolyte chamber with baffle type adjustable current distributors and expanded titanium mesh anode surface. The cathode chamber is made up of special grade stainless steel chamber with current distributors and catalytic coating cathode. The bonding of these two chambers has been done by electrothermal process which reduces the cost of the bonding and also voltage drop to minimum and baffle arrangement enhances the turbulance and provides uniform electrolyte flow and concentration.

### Perfluorinated acids, amines and ethers

Electrochemical perfluorination is the only commercially viable perfluorination process for the production of perfluorocarbon surfactants and perfluorocarbon inert fluids required for electronic industry and biomedical applications. CECRI has developed a process for making perfluoro octanic acid which has been found to have the requisite specifications.

### Pt-Re skewed reforming catalyst

Pt-Re bimetallic catalyst is generally used in semi-regenerative type of catalytic reforming units. IIP had earlier developed a balanced Pt-Re catalyst which is in commercial use in two Indian reformers, for octane boosting in one and in the other for xylenes production. The catalyst has been working very satisfactorily for the last 7 years. IIP has now developed skewed type high rhenium catalyst used for catalytic reforming which has better activity, selectivity and high stability than the normal Pt-Re catalyst. The reforming process temperature is reduced by 5-6°C with this catalyst which has around 15% more stability.

The scale up of know-how for catalyst production will be jointly carried out with industry which will then commercially manufacture it. The prospective users are the existing semiregenerative reformers in the country. The catalyst has high export potential.

### Technology for desulphurisation of gases

In the fight against air pollution, arresting emission of hydrogen sulphide from petroleum refineries and natural gas processing plants is of prime importance. With even tougher environmental regulations in the offing, this becomes a necessity. IIP, in collaboration with a

major Indian refinery has developed a catalytic desulphurisation process at pilot scale, including development of a novel catalyst that can remove hydrogen sulphide upto less than 4ppmv from gas streams containing as high as 10% wt/vol of $H_2S$.

The catalyst formulation contains a novel promoter besides other ingredients and is much cheaper and superior in its efficiency for regeneration, leading to drastic reduction in size of the oxidiser. The catalyst is to be tested in an existing commercial unit. This development provides an indigenous technological solution to controlling environment pollution from existing petroleum refineries, fertiliser and petrochemical plants as well as natural gas production facilities.

## Sweetening catalysts

The presence of mercaptans in the petroleum products like LPG, naphtha, gasoline, kerosene, ATF etc is undesirable due to their foul odours and highly corrosive nature. Sweetening of petroleum products is through catalytic processes using metal phthalocyanine derivatives as catalysts.

IIP has developed two sweetening catalysts namely catalyst-I (WS) and catalyst-II (FB). Catalyst-I (WS) is suitable for liquid-liquid sweetening of pentanes, light straight run naphtha and regeneration of alkali in the mercaptan extraction from LPG while catalyst-II (FB) is suitable for sweetening of heavy naphtha, FCC gasoline, ATF and kerosene in the fixed bed reactor containing catalyst impregnated on activated charcoal. Both the catalysts developed have shown better performance than commercial catalysts in model laboratory experiments designed to suit actual refinery conditions. Steps are being taken to test these catalysts in actual refinery operations in one of the refineries in the country.

## $C_{10}$-$C_{18}$ secondary alcohols

IIP has developed an innovative process for production of $C_{10}$-$C_{18}$ secondary alcohols through n-paraffins oxidation in liquid phase. These alcohols are valuable feed stocks for production of surfactants.

A novel catalyst has been developed which gives selectivity of 90% at 40% conversion per pass in comparison to current processes which give 81-90% selectivity at 15-22% conversion. The development work has been done at laboratory scale under PATSER programme of DSIR along with an industrial partner.

## Low pressure process for NMP production

NMP is the latest generation solvent employed for removal of poly nuclear aromatic hydrocarbons from raw lube oil feed stocks to make better quality lube oil base stocks (LOBS). A new low pressure process for production of NMP has been developed at IIP at laboratory scale, using Gamma butyro lactone as the feed material. The laboratory studies have been completed and process design and scale-up to 2500 TPA plant is in progress. The process has been developed in collaboration with industry.

## Flyash-based zeolites

NEERI has developed a process for production of flyash-based zeolites (FAZ) by fusing fly ash with caustic soda. Three zeolite phases, viz., Zeolite-A, Zeolite-X, and Zeolite-Y have

been identified with calcium binding capacity (CBC) ranging between 500/600 meq/100 g, 360-380 meq/100 g, and 400-500 meq/100 g, respectively.

The high value of CBC for Zeolite A indicates its potential as phosphatic detergent binders. The technology developed is cost effective, provides a commercially feasible substitute for environmentally harmful phosphatic detergent binders, and leads to high value utilisation of flyash with concomitant resolution of flyash disposal problem.

### Colloidal silica

Colloidal silica is a source of fine particles and high surface area for innumerable industrial applications. It is used as binder in textile, paper, synthetic polymers, precision casting and refractory industry. CSMCRI under sponsorship from industry, took up upscaling to 30 kg/batch level of its earlier developed laboratory scale process for production of colloidal silica. Based on the data generated, plant design for 300 kg/batch was worked out and project report submitted to the sponsor who will be installing a 1.5 TPD plant at Naroda Industrial Estate, Ahmedabad.

### Brine purification resin

CSMCRI has developed an acrylic type amino methyl phosphoric acid type resin for brine purification. Presently the demand for these resins is totally met through imports. Bench level studies of brine purification have revealed better performance in comparision to the imported resins which are essentially of styrenic type and involve the highly carcinogenic chloromethyl ether in their synthesis. The know-how is being upscaled to pilot plant level in collaboration with industry.

## SERVICES

### Industrial safety and risk analysis

Industrial safety and risk analysis is an emerging field of chemical engineering with tremendous potential. Accordingly both CLRI and IICT have set up specialised cells to render advice and consultancy to industry on hazards, risk analysis and safety. Both the cells have developed expertise that is recognised nationally and internationally. Major petroleum industries and oil & gas companies are among the reputed clientele. These cells have been organising intensive training programmes on Hazop, Consequence Analysis & Safety Audit for clients.

### Electroforming

CECRI continued its work on electroforming of Cryogenic rocket engine thrust chamber, the electroforming of cryogenic upper stage main engine and steering engine was completed. The engine is likely to be used for the GSLV space programmes of ISRO.

### Techno economic feasibility studies

IIP carried out a detailed feasibility study for establishing a petrochemical plant after studying national and international present and future scenario. The study was carried out at the request of a private industry under its sponsorship.

State-of-art report on use of alternative fuels for motor vehicles to control vehicular emission in metropolitan cities has also been prepared.

### Bruker FT-NMR facility

A Bruker RPX200 MHz FT-NMR for elucidation of structures of liquids has been procured and installed at CSMCRI. Solid samples could also be analysed using the CP-MAs attachment available.

The facility has been used to provide elemental analysis of several metal complexes synthesized for catalytic studies, polymers, bioactive materials extracted from marine algae, salt, inorganic materials, zeolites and clay samples. Single crystal X-ray studies have been carried out for polypyridly Ru and Rh complexes, thermochromic materials and metal-organic polymeric networks. The service was extended to universities, national laboratories and industries against payments.

## HUMAN RESOURCES DEVELOPMENT

### Training in industrial safety and risk analysis

IICT in association with the Cell for Industrial Safety and Risk Analysis (CISRA) of CLRI, conducted intensive training courses on Hazard and Operability Studies (HAZOP), Consequence Analysis (CA) and Safety Audit (SA) for practising engineers connected with chemical, petrochemical, petroleum and process industries as well as personnel from government regulatory agencies. Three courses held during the year covered concept of hazard and operability studies, hazard identification techniques, major hazard control legislations, case studies of hazardous chemical processes and also provided hands-on training on computer software programmes and safety audit.

### International training course on mass spectrometry

The eleven day training programme conducted by IICT had participants from Egypt, Saudi Arabia, Sri Lanka, Thailand and Turkey. The specially designed course contents covered fundamental aspects of mass spectrometry and advanced techniques based on electron (EI), chemical (CI) electrospray, thermal and inductively coupled plasma ionization, fast atom bombardment (FAB) and matrix assisted laser desorption (MALD) with focus on the applications of gas chromatography, mass spectrometry (GC-MS) and liquid chromatography mass spectrometry (LC-MS). The participants were also given hands-on demonstrations on the various techniques.

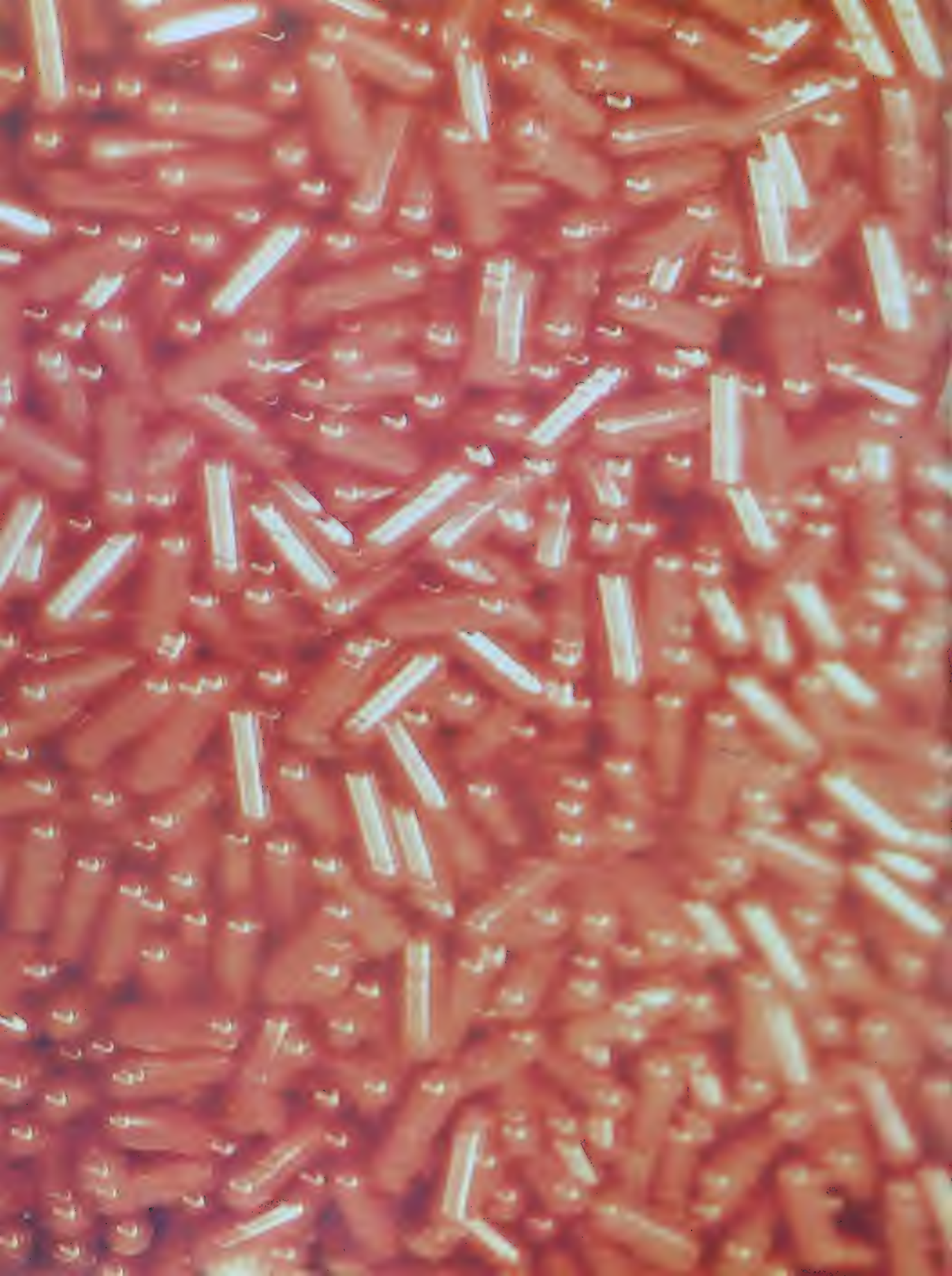
### Workshop on molecular structure determination

A workshop on molecular structure determination by spectroscopy and diffraction methods was organised by CSMCRI in February, 1997. About 40 participants from industries and universities in Gujarat had the benefit of knowing the recent developments in the area of spectroscopy and diffraction techniques for structure determination of inorganic and organic molecules.

## RECOGNITIONS & AWARDS

| | |
|---|---|
| INSA Young Scientist Medal for Chemical Sciences | Chandrasekhar, Dr (IICT) |
| First R.C. Shah Memorial Outstanding Chemist Award by Indian Science Congress (1996)<br>Fellow, The National Academy of Sciences, Allahabad | Ganesh, Dr KN (NCL) |
| CSIR Technology Prize for Chemical Technology (1996) | Sarvashree Hari Simha; Narayan Reddy; Patwari, AN; Ramakrishna, D; Ramanayya, KV; Usha, (Mrs); and Virendra, Sri (IICT) |
| Catalysis Society of India Fr. Lourdu M. Yeddanapalli S.J. Prize in Catalysis | Keshavaraja, Dr A (NCL) |
| CSIR Young Scientist Award in Engineering Sciences | Lele, Dr A K (NCL) |
| Durga Prasad Khaitan Memorial Gold Medal (1996) | Mashelkar, Dr RA (CSIR) |
| Fellow, UK Institute of Chemical Engineers (1996) | Mashelkar, Dr RA (CSIR) |
| Fellow, The Linnean Society of London | Nadgauda, Dr (Mrs.) RS (NCL) |
| INAE Young Engineers Award 1996 | Ranade, Dr V V (NCL) |
| Fellow, Third World Academy of Sciences, Italy | Ratnasamy, Dr Paul (NCL) |
| Fellow, Indian National Academy | Sandhu, Dr JS (FNA) (RRL, Jt) |
| Shri Om Prakash Bhasin Award for Science and Technology (1995) | Sivaram, Dr S (NCL) |
| FICCI Award for Physical Sciences | Sivaram, Dr S (NCL) |
| Catalysis Society of India Eminent Scientist Award (1996) | Sivasanker, Dr S (NCL) |
| Catalysis Society of India Young Scientist Award (1996) | Vetrivel, Dr R (NCL) |

# Drugs & Pharmaceuticals



CSIR's efforts were directed towards developing screens and models for several diseases and finding new leads for potential drugs. The co-ordinated programme reported in the Overview forms the bedrock of CSIR's programme on new drug development.

## SCIENCE

### Synthesis of different varieties of peptides and design of molecular recognition induced receptors

A novel design strategy for the synthesis of conformationally constrained cyclic peptides based on the incorporation of semi-rigid aromatic or non-aromatic templates into the cyclic backbone has been delineated at RRL,Tvm.

This novel class of cyclic peptides has now been demonstrated to transport, selectively, alkali metal ions across liquid bilayer membranes and thus are potentially useful as leads for designing novel ionophoric antibiotics. Totally chiral, multiple armed peptide based dendritic scaffoldings have been prepared and demonstrated as globular protein mimics.

Novel, molecular-recognition induced, dicarboxylic acid receptors have been designed and shown to self-assemble in persistently one dimensional motifs, while minimalistic chemical models for Zn-finger proteins designed, synthesised and studied for DNA interactions, were seen to be the mimics of Zn-finger proteins.

### Novel $C_2$ symmetrical HIV protease inhibitors

$C_2$ - symmetrical HIV protease inhibitors can coalign with $C_2$ -symmetrical HIV protease and therefore are of tremendous interest in anti AIDS chemotherapy. IICT had undertaken research on $C_2$ -symmetric and $C_2$ - pseudo symmetric diaminodiol HIV protease inhibitors.

For the first time IICT was able to introduce different substitutions in aromatic ring of HIV protease inhibitor by developing a new synthetic protocol. HIV protease inhibitors are being used along with reverse transcriptase inhibitors in what is known as 'cocktail' chemotherapy of AIDS.

### Azamacrolides

A novel family of alkaloids isolated from Mexican bean beetle pupae were found to be responsible for exciting defence mechanism. These structurally complex microlides are present in nanogrammes in insects.

IICT has now synthesised these bioactive macrolides in the laboratories in milligram quantities and submitted for testing to Cornwell University, USA. The stereo selective synthesis to elucidate the absolute stereo chemistry and to study stereo chemical structure - activity relationship have been undertaken.

### Effect of curcumin on certain lysosomal hydrolases in isoproterenol - induced myocardial infarction in rats.

The effect of curcumin on lysosomal hydrolases in serum and heart was studied at CLRI by determining the activities of β-glyxueonidase, β-N-acetylglucosaminidase, cathepsin B,

cathepsin D, and acid phosphatase. Rats treated with isproterenol showed a significant increase in serum lysosomal hydrolase activities, which were found to decrease after curcumin treatment. Isoproterenol administration to rats resulted in decreased stability of the membranes, which was reflected by the lowered activity of cathepsin D in mitochondrial, lysosomal and microsomal fractions.

Curcumin treatment returned the activity levels almost to normal, showing that curcumin restored the normal function of the membrane. Histopathological studies of the infarcted rat heart also showed a decreased degree of necrosis after curcumin treatment. Curcumin could thus be a potential drug, if taken along with diet for protective therapy.

### Primate model for visceral leishmaniasis

A primate model of visceral leishmaniasis/kala-azar for screening of potent leishmanicides and immunoprophylactics has been standardised at CDRI in the Indian langur *(Presbytis entellus)* which was found to be highly susceptible to leishmania infection and developed symptoms comparable to the clinical situation.

This monkey model has recently been adopted by Tropical Disease Research (TDR) programme of WHO and CDRI has been given the responsibility of evaluating the WHO vaccine.

### Primate model for human filaria

For the first time in India CDRI successfully established *Wuchereria bancrofti* infection with microfilaraemia in male Indian leaf monkey *(Presbytis entellus)* with high recovery of adult parasites. This animal model is extremely important for both chemotherapeutic and immunological studies as 90% of Indian lymphatic filariasis is caused by *W. bancrofti* infection.

### Factors facilitating wound healing

Wound healing as a normal physiological process is mediated by the generation and expression of different growth factors and angiogenesis. Proteins expressed during normal healing process in guinea pig punch wounds were partially characterised at CDRI and six of the proteins appeared new or overexpressed at the time of active phase of healing.

A decrease in peroxides and enzyme and non-enzymic antioxidants in cutaneous wound tissue was observed suggesting that different free radical scavangers or preparations which can elevate the levels of antioxidants in situ can be utilized to facilitate wound healing.

### Partially folded intermediates of proteins and their aggregation behaviour

Aggregation of partially folded or misfolded proteins, a potential side reaction in protein folding, both in vivo and in vitro has serious implications in biotechnology and biomedical research.

The phenomena has been found to be an underlying cause or an associated symptom of several disease pathologies like Alzheimer's disease, Down's syndrome, malignant myeloma and crush injury and a major problem in the prodution of recombinant proteins especially in bacterial systems.

CDRI conducted structural characterization of a partially folded state of hen egg white lysozyme, a globular protein detected at low pH (1.5). The studies provided insights into the possible features responsible for stabilization of intermediates in folding of hen egg white lysozyme and their aggregation.

### Finger printing of mycobacterium infection

High resolution in vivo and in vitro two dimensional NMR spectroscopy studies carried out at CDRI on human tuberculosis granuloma revealed the possibility of finger printing of mycobacterium infection.

This observation acquires great relevance as CNS tuberculosis occurs in 2-5% of all patients affected with mycobacterium species. Finger printing of *M. tuberculosis* cell wall biochemicals in the granuloma may help in facilitating the diagnosis where routine histology and culture are not conclusive.

### Chiral epoxides

Synthesis of chiral expoxides by catalytic epoxidation of non-functional alkenes has been reported by CSMCRI. Chiral epoxides have potential applications as intermediates for synthesis of complex bioactive molecules such as leukotrien, erythromicine (antibiotic), crixivan (an HIV protease inhibitor) and cromakalin (a high potent antihypertensive) and also as end products like disparlure, the sex pheromone of gypsy moth as eco-friendly pest management agent.

More than 85% enantiometric induction has been achieved for the enantioselective epoxidation of prochiral non-functional alkenes using series of dissymmetric and dehydroacetic acid with resolved diamines as catalysts. The alkenes studied include styrene, substituted styrene, cis stilbene, indene, chromenes, long chain terminal and middle alkenes. The R&D efforts have been directed to develop simpler chiral catalysts, using inexpensive metals and oxidant and robust ligand.

## TECHNOLOGY

### Lamivudine

Lamivudine is a clinically useful anti-AIDS drug and essential for the cocktail therapy for AIDS comprising AZT, lamivudine and an HIV protease inhibitor. The present process of manufacture of lamivudine utilises ozone, an hazardous chemical. IICT has developed an alternate route totally dispensing with ozone. This modification in technology will have tremendous impact on the international price of lamivudine.

The development is being patented. The technologies for AZT and stavudine earlier developed by IICT based on thymidine produced through a novel and most cost-effective route via D-xylose have been commercialised and the two drugs introduced in the Indian market at prices several times lower than the international prices. The novel process for production of thymidine has been granted a US patent in January 1997. IICT has initiated work on development of HIV protease inhibitor also.

### Production of cyclosporin-A by fermentation process

Cyclosporin A (CSA) is an excellent immunosuppressive drug needed for organ transplantation surgery. Studies at RRL, Tvm on production of CSA using Tolypcladium inflatum B-58 were directed towards a viable and economically feasible fermentative method of production. The impact of various physical and chemical process parameters were optimzied and encouraging results were obtained. Medium supplementation with an amino acid further improved CSA synthesis by the fungal strain. A whole cell immobilised bioreactor was designed to study the biotransformation efficacy of the bioactalyst embodied in various encapsulation agents. Bioreactor operations were successfully monitored in batch and recycling modes. Efforts are on to negotiate an industrial partner for the technology development and scale up studies.

### Simultaneous production of artemisinin and essential oil from Artemisia Annua

*Artemisinin* and its derivatives from *Artemisia annua* plant are important antimalarial drugs because of their activity against resistant strains of *Plasmodium falciparum* and their efficacy against cerebral malaria. *A. annua* is also a good source of essential oil. The essential oil shows dermatological, antimyotic, anti-microbial and specific fungicidal properties. Cultivation of *A. annua* has now been adopted as a commercial crop throughout the world.

In the conventional process for isolation of artemisinin, the non volatile constituent of the plant used for the production of antimalarial drug, the volatile constituent (essential oil) goes as a waste. An integrated process has now been developed at CIMAP which enables isolation of artemisinin as well as 75% of essential oil. The process offers the advantages of obtaining both artemisinin and essential oil by a single process; despenses with the removal of fatty material that reduces artemisinin content; the partitioning step selectively transfering the sesquiterpene into polar phase and fatty and other impurities in non polar phase for better recovery of both the products and enables recovery of 90% of solvents for reuse. The process is continuous, cost effective and eco-friendly.

### Antirelapse antimalarial drug

Plase II clinical trials on an enamine derivature of primaquine, as an antirelapse antimalarial drug developed at CDRI have been concluded. The drug has been found to be much safer than primaquine in patients of *Plasmodium vivax* as indicated by low methaemoglobinemia. The compound will be evaluated for its use as a prophylactic agent against *P. falciparum* malaria.

## SERVICE

### Aero-allergens survey

In an epidemiological survey of aeroallergens done by CBT in 5 different centres, it was observed that the incidence of respiratory diseases ranged from 10-30% in children and adults. This points to an urgent need for development of better diagnostic and therapeutic measures for allergic disorders.

## NICDAP facility

The National Information Centre for Drugs & Pharmaceuticals (NICDAP) at CDRI has strengthened its CD-ROM library to provide latest information by possessing the databases on Chemical Abstracts, Biotechnology Abstracts, International Pharmaceutical Abstracts, Drug Information Sources - full text, Excerpta Media (Drugs & Pharmacology), Current Contents, Medline & Popline.

NICDAP continued to publish two current awareness bulletins 'Industry Highlights' and 'R&D Highlights'. The reach of NICDAP has been substantially increased by CDRI becoming a Distributed Information Sub-Centre of the Biotechnology Information System; WHO Collaborating Centre of the Biotechnology Information and Nodal Agency for Pharmacology and Phytochemical Database under INMEDPLAN and with connectivity to INTERNET.

# HUMAN RESOURCES DEVELOPMENT

## Training programmes under bilateral co-operation

CDRI conducted three training programmes for foreign trainees under various bilateral co-operation arrangements. These were for:

- Evaluation of medicinal plants and techniques for isolation of active principles from plant extracts for scientists from Bangladesh Council for Scientific & Industrial Research (BCSIR) under the CSIR-BCSIR Working Programme on S&T Co-operation.

- Techniques in pharmacology and toxicology for a scientist from union of Myanmar under WHO fellowship.

- Biological evaluation and pharmacokinetic studies in drug development for scientists from West Indies under the DST-TWAS-South-South-Fellowship.

## Advanced technology training programme

CDRI conducted training in areas of R&D capabilities of the institute for persons from drug industry. The training comprising of lectures and practicals was in the area of design and synthesis of molecules and approaches for developing processes for known drugs and isolation of natural products/ purification techniques.

## Adhoc training

CDRI gave adhoc training to students from universities and other medical research institutes in ELISA technique for detection of *M. tuberculosis*, general mycobacterial techniques, filarial infections, fermentation technology and microbiology, antibiotic fermentation, instrumentation, technique in pharmacokinetics and metabolism etc.

## RECOGNITION & AWARDS

| | |
|---|---|
| K.G. Naik Gold Medal for outstanding contribution to Science (1994) | Bhaduri, Dr AP (CDRI) |
| CSIR Young Scientist Award (1996) | Bhakuni, Dr Vinod (CDRI) |
| ICMR Shakuntala Amirchand Prize (1996) | Dikshit, Dr (Mrs) Madhu (CDRI) |
| Ved Prakash Seth Foundation Award for contribution to Health Care (1996) | Kamboj, Dr VP (CDRI) |
| Fellow of the Indian Society for Parasitology | Katiyar, Dr JC (CDRI) |
| Sri Om Prakash Bhasin Award for Science & Technology (1995) | Srivastava, Dr BS (CDRI) |
| Fellow of American Academy of Microbiology, USA | Srivastava, Dr BS (CDRI) |
| INSA Young Scientist Award (1996) | Srivastava, Dr Pratima (CDRI) |

Earth Resources

ROSS-Remotely Operable Sea Skimmer (above) for bathymetric surveys being readied (below) for field studies

CSIR's work has been in the study of earthquake processes and seismic hazard assessment besides study of ocean resources and processes. This has enabled it to delineate gas hydrates and mesozoic sediments as possible sources of hydrocarbons.

**SCIENCE**

## Seismicity pattern in Shillong-Mikir plateau

The eleven years (1982-1993) study by RRL, Jt of seismicity (focal depths <60km) in the Shillong-Mikir massif of NE India (25°-27°N) has ravealed that a concentration of events took place in the depth range of 20 to 40 km (70% of the activity), and the compressional axis of most of the events is oriented along north-north-westerly direction.

## Earthquake processes and seismic hazard assessment

Digital data from the telemetry network in NE India (since the year 1993) has been analysed by NGRI and seismically active lineament between Shillong plateau and main boundary fault delineated. An examination of the Earthquake catalog since historic (1762) to recent times (1996) showed regular cycles of alternate inactive (non-occurrence of earthquake of magnitude >7.7 and active (occurrence of number of earthquakes of magnitude >7.7) periods in the northern part of the Indian Plate Boundary (NIPB). It is also observed that during the active phase of NIPB, the Indian shield is rather inactive (non-occurrence of earthquake of magnitude >6.0) and during the inactive phase of the NIPB the Indian shield area is active (occurrence of 1 or more earthquakes of Magnitude >6.0). This provides an insight for generation of a suitable model for long term prediction of strong earthquakes in the Indian subcontinent and attendant seismic hazard assessment.

## Geotransect in the central Indian shield

A geotransect across the central Indian craton, using the gravity, magnetic, magnetotelluric, seismic and geological data has been prepared by NGRI. Combined interpretation of seismic and gravity data indicate the presence of a local magnetic body at mid crustal depth in the Satpura Mobile belt. The crust mantle boundary in this area is at depths varying between 40 and 44 km. The seismic reflection data set identifies the presence of a suture at the boundary of Satpura and Kotri-Dongargarh Mobile Belts.

## In-situ pore pressure and stress regime

For continuous seismic monitoring of the Koyna region, pore pressure monitoring was carried out by NGRI at 5 wells drilled to a depth of 200 m. The spectral analysis reveals existence of the lunar and solar tidal effects and indicates dominance of solar over lunar constituents. This signifies thermomechanical stresses from heating and cooling of the rocks at the surface.

## Assessment of continental and marine gravity

A new approach has been evolved by NGRI for synthesising continental gravity data to identify regional negative bias which masks other anomalies of geological interest in Bouguer gravity. With this approach a new residual anomaly map for any region can be prepared. A new approach for marine gravity data is evolved to identify residual anomalies by separating gravity effects caused by bathemetry topography. The approach helps to identify probable density of sea bottom topographic mass and sea mount etc.

### Hydrothermal activity in the Central Indian Ocean Basin (CIOB)

Studies carried at NIO has provided evidence of recent volcano-hydrothermal activity in the CIOB otherwise considered to be inactive in terms of the volcanic eruptions. High concentration of volcanic magnetite spherules and their possible origin from a liquid immiscible silicic-basic magma or from hydrovolcanic activity has been traced and based on the age of the associated radiolaria, an age of ~10 ka is suggested for the last episode of volcanic-hydrothermal activity in the CIOB.

### Crustal evolution of the Bay of Bengal

NIO has offered a new insight into the breakup of India from eastern Gondwanaland and post-breakup events of the northeastern Indian Ocean, which suggest that Greater India separated from Antarctica in the early Cretaceous, and drifted northwestward. Geophysical study indicates the boundary between continental and oceanic rocks at the foot of continental slope, about 80 km seaward of the present continental self edge. Eight seismic seuences, as thick as 8.5 km, overlie the early Cretaceous oceanic basement and include four unconformities (lower Eocene, upper Oligocene, upper Miocene, and upper Pleistocene) which have been correlated to the major geological/tectonic events.

### Modelling of observed inter-annual variabilities over the Indian Ocean

Mechanisms of interannual variabilities observed over the Indian Ocean have been identified by C-MMACS by developing relatively simple process models. It is shown that many of the observed features of these variabilities can be simulated when certain physical processes involving moist dynamics appropriate over the Indian ocean region are included. The role of the basin configuration is also highlighted. These findings can provide significant insight to develop models with better forecast skill for the Indian Ocean region.

### Modelling of Arabian sea ecosystem

A coupled physical biological model of Arabian sea has been developed by C-MMACS to explain the annual cycle in the primary productivity. The biological model consists of phytoplankton, zooplankton, bacteria and four forms of nutrients and the physical model is a versatile Ocean Global Circulation Model. The model reveals the onset of the bloom in July, its persistence in September and its disappearance thereafter.

### Coastal Ocean Monitoring and Prediction System (COMAPS)

COMPAS is a DOD funded long-term program at NIO, for monitoring the quality of sea water along the coast. Observations made along 8 transacts between Ratnagiri and Mangalore revealed the highest salinity in the northern section of Ratnagiri and Malvan, with depthwise distribution in salinity increasing from surface downwards. The dissolved oxygen concentration however were generally high in surface waters while the bottom water showed oxygen deficiency. Lowest values of oxygen were observed in the northern transacts. It was observed that these low oxygen bottom waters were associated with relativèly high nutrients, especially nitrite, which is attributed to the residual effect of monsoonal upwelling along this coast, by which oxygen-depleted and nutrient-rich waters from intermediate depths in the Arabian sea are brought to the surface near the coast. From the observed values of oxygen and nutrients it appears that the presence of nitrite associated with measurable amounts of oxygen in the bottom waters is due to the eastward spreading of the water layer containing primary nitrite maximum in the Arabian sea.

## Dual isotopic composition of nitrous oxide in the Arabian sea

Measurements of dual isotopic composition of $N_2O$ in the oxygen-deficient zone of the Arabian sea showed that denitrification at mid-depths in the Arabian sea leads to enrichments of both $^{15}N$ and $^{18}O$ in $N_2O$ that are by far the largest reported from any natural environment. NIO also acquired the first data set on isotopic composition of $N_2O$ from an intense upwelling zone (off the Southwest coast of India) where some of the highest concentrations of $N_2O$ at the sea surface were observed. These and results of other experiments provide important insights into the mechanisms of $N_2O$ production and also support the proposition that while denitrification may be the principal mechanism for the production of isotopically heavy $N_2O$ in the deeper layer, isotopically light $N_2O$ in the upper water column may be produced dominantly through nitrification-denitrification coupling involving nitric oxide.

## Mechanism of high biological production in the Arabian sea

Studies conducted at NIO indicate that the Arabian sea is one of the most biologically productive oceanic regions mainly due to the upwelling of nutrients during the summer (southwest) monsoon. It was noticed that the northern Arabian sea continues to sustain fairly high biological production even after the upwelling season. Physical, chemical and biological data generated indicate that sea surface cooling drives convection processes that lead to the injection of nutrients up into the surface waters of the northeastern Arabian sea during winter, and that this mechanism of nutrient supply has a dominant control over winter productivity.

## Characterisation of continental margins of India

NIO, undertook studies to ascertain the geological and geophysical characteristics of the seas along the Indian peninsular.

**Western margin:** study of closely spaced marine magnetic profiles in the northern Arabian sea indicated that most of its identified magnetic lineations are segmented by oblique offsets representing pseudofaults associated with paleo-propagating ridges. This suggests that the early territory seafloor spreading in the sea was characterised by systematic ridge propagation probably caused due to the influence of former position of the Reunion hotsport on the spreading segment. The analysis of the calcareous deposits off Bhatkal at 50-58 m water depth showed that these occur as crust, sheets, cylinders and reddish brown mudstones. Thereby indicating that the particulate matter in the calcareous deposits was initially at the proximity of the coast and cemented by metastable calcites during the ultimate Pleistocene interglacial sea level stands on the shelf. Pedogenic cementation processes overprinted and developed them into eolianites and paleosols during the subsequent late Pleistocene sea level regression.

**Eastern margin:** geophysical studies of eastern continental margin of India (ECMI) indicated three major lineaments while magnetic modelling indicating a shallow basement at a depth of about 5 km flanked by deeper source both north and south. Geomorphic features such as fault valleys, V-cut channels and sediment slumps are also inferred from high resolution sparkler data along two E-W trending lineaments off Madras and Nagapattanam which provide evidences for recent tectonic activity in this part.

## Rainfall patterns using neural networks

Long-range forecast of rainfall patterns can provide significant boost to the country's economy through advanced planning and crisis (e.g. drought) management. The conventional dynamical and statistical methods however, still do not possess adequate skill in long-range forecast of rainfall patterns, especially at longer than seasonal scales. The cognitive networks developed at C-MMACS have shown considerable skill in hindicast of all-India means summer monsoon rainfall and provide a general tool for forecast of rainfall pattern at various scales.

## Delineation of mesozoic sediments under the Deccan trap in Saurashtra

NGRI successfully completed the integrated geophysical studies in the Saurashtra region, in an area of about 80,000 sq km, under the ONGC sponsored project at locating possible hydrocarbon bearing mesozoic sediments below the Deccan traps in Saurashtra region for oil exploration. The data analysis is in progress. The velocity depth analysis across the Lodhika deep well indicated the presence of a thick trap layer overlaying the Mesozoic sediments. Detailed analysis suggests presence of a second layer of volcanic formations below Mesozoic sediments in some parts. Modelling of the magnetotelluric data provided information of the basement configuration and also confined the presence of thick sedimentary column to north and north-west region of Saurashtra. The gravity (appox. 10,000 stations) data were processed and free and bouguer anomaly maps of Saurashtra for different density contrasts prepared.

## Identification of gas hydrates

A study to identify potential gas hydrates site was initiated at NGRI under a project sponsored by Gas Authority of India Ltd. The seismic reflection method was used as a possible tool for identifying gas hydrate deposits. Reprocessing of existing seismic data, across the western continental margin of Mangalore coast, indicate the possible existence of gas hydrates bearing zones.

## Remotely operable sea skimmer

NIO has designed a remotely operable sea skimmer (ROSS)-an autonomous unmanned vehicle for bathymetric surveys to complement manned survey vessels in hazardous environments. Two distinct proofs of concept versions of the ROSS hull have been conceived and implemented in the field using a theter. In ROSS version 1, the vehicle is a standard catamaran hull fitted with stabilising shegs. In a second patented version the hull is made from a free flooding HDPE tube enclosing 3 buoyant sealed bins containing batteries and electronics. Both versions are equipped with a GPS (Global Positioning System) to measure position on the sea surface. Additional sensors on ROSS include a low cost echosounder, digital compass, temperature and a UHF radio modern for remote control of the craft.

## Gold mineralisation

Geological, petrological, ore microscopic and geochemical studies on gold were carried out by NGRI in select areas from the sulfidic banded iron formations of Chitradurga and Sandhur schist belts of Dharwar creation. Gold anomaly maps for some localities have been prepared and mineralised zones delineated.

Appreciable gold values were obtained in Kunchiganahalu area. On the basis of geostatistical OR models NGRI provided inferences on the persistence of gold mineralisation, both laterally and depth wise, for a zone in Hutti gold fields. Optimum sampling designs proved that the sampling size can reduce to half of the present size without compromising on the accuracy of estimates. This has resulted in significant savings to the gold mining industry at Hutti.

### Water run off, percolation and pollution studies

Experiments for enhancement of runoff were initiated by NGRI for studying the usefulness of Polymer solutions in developing social forestry. A chloride method, sensitive enough to detect small changes in percolation fraction due to environmental effects, was developed. Samples of soil, surface water and groundwater collected from industrial areas in Medak district of AP during pre-and post-monsoon periods were analysed/studied for their chemical composition, specially the toxic elements. Many heavy metals/toxic elements were found to be present much above the permissible limits.

### Weak zones in granites

Under a project sponsored by BARC, NGRI conducted integrated geophysical studies comprising the deep resistivity and electromagnetic sounding to detect the structural inhomogeneities upto a depth of 1 km in granitic terrain of Jaisalmer. The modelling of integrated data indicated the presence of two major structural trends that broadly correspond to weak zones. The study testifies the usefulness of geophysical methods in mapping deep seated structural inhomogeneities in granitic terrain.

## SERVICES

### Research station at Antarctica

NGRI initiated a project (GPS station) at Antarctica during the XVI expedition to make a precise study of the interplate movement and crustal deformation between India and Antarctica. The initial short term measurements, for about 45 days, along with estimation of intercontinental baseline will help to study the global absolute crustal uplift which is equal to the expansion of earth's radius. Feasibility study to select a suitable site with very low cultural noise was undertaken for installing a permanent state-of-the-art digital seismological station at Maitri. An analog seismograph was operated for a period of 45 days without any operational problems.

### National Information Centre for Marine Sciences (NICMAS)

NICMAS was established under NISSAT at NIO to extend the library services to different users. The Centre, holding many international data bases on aquatic studies, also provides consultancy on establishment of information units. It also offers training in database creation and information search, besides performance evaluation of individuals and organizations.

## HUMAN RESOURCES DEVELOPMENT

### Training in oceanography

Two Mauritian scientists were trained at NIO, one on 'taxonomy of marine phytoplankton with special emphasis on harmful species' and the other on 'operation and maintenance of S4 current meters and wave measuring equipment' under the ITEC/SCAAP Programme. Also four naval officers underwent familiarisation course in METOC instrumentation at NIO in March 1997.

### Training on ORV Sagar Kanya

Forty students from the Universities of Andhra, Cochin, Mangalore, Goa and Madras were imparted onboard training in deployment of instruments, sample analysis, data collection and processing, during the scientific Cruises 112-121 of ORV Sagar Kanya.

### GIO-96 Symposium

An international symposium on 'Geology & Geophysics of the Indian Ocean (GIO-96)' was held at NIO, Goa in October, 1996. The symposium had participation of 180 scientists representing USA, Japan, United Kingdom, Russia, Canada, Norway, Sweden, the Netherlands and India. Sponsored by CSIR, DOD, NOR (USA), DST, ONGC, GAIL, and International Lithosphere Programme the symposium aimed at expanding the presently available knowledge base on the Indian Ocean.

### Workshop on Global Ocean Observing System (GOOS)

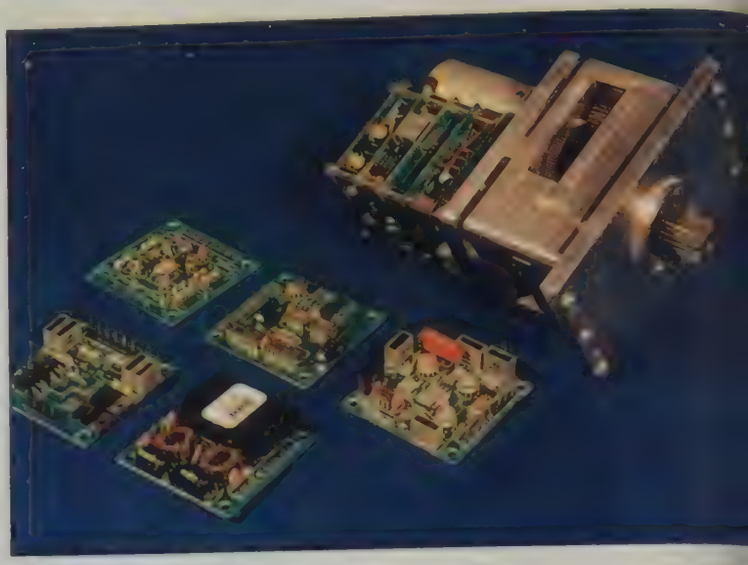
A workshop on GOOS under the auspices of the Intergovernmental Oceanographic Commission (IOC), UNESCO and the DOD, Govt. of India was organised by NIO during November, 1996. This workshop was to assess the existing capabilities of IOC member countries (Australia, Bangladesh, France, Germany, India, Indonesia, Islamic Republic of Iran, Kenya, the Netherlands, Qatar, Republic of Maldives & Sri Lanka) and strengthen their capacity to fully contribute to the GOOS programmes. The workshop was followed by the second session of IOC Regional Committee for the Central Indian Ocean(IOCINDIO-II) intended to promote and co-ordinate the implementation of co-operative research programmes among member countries.

## RECOGNITION & AWARDS

| | |
|---|---|
| CSIR Young Scientist Award Physical Sciences (1996) | Manglik, Dr Ajay (NGRI) |
| A.P. Academy of Sciences Young Scientist Award (1995) | Ramana, Dr (Ms) Venkata & Singh, Dr AP (NGRI) |
| National Mineral Award (1995) | Reddy, Dr PR (NGRI) |
| Indian Geophysical Union Krishnan Medal (1996) | Sain, Dr Kalachand (NGRI) |
| Indian Science Congress Association Young Scientist Medal (1997) | Sreenivas, Dr B (NGRI) |

# Electronics & Instrumentation

Atomic Force Microscope



PWM Actuator Amplifier

First laboratory prototype of 5MW Pulsed
S-band KLYSTRON

Opthalmoscope and otoscope diagnostic set

Inductive electromagnetic soil salinity testing system

CSIR's effort has been to develop appropriate devices and instrumentation required by the Indian industries and custom tailored to specific needs of clients.

## SCIENCE

### Novel techniques in FT NMR correlation methods

Novel methods were developed at CLRI to generate:

- quantitative information on molecular self-diffusion in liquid-like multicom-ponent systems in heterogeneous environments by NMR;
- pure phase multidimensional NMR by a single procedure of reference frequency shift (RFS).

The diffusion measurement method developed results in a fast, two scan protocol to measure the self-diffusion coefficient D, of each component in a system. This procedure scores over the standard procedure that involves measurement times that are a couple of orders of magnitude longer besides suffering from infirmities in dealing with multi-component systems. Also the novel procedure of RFS for pure-phase multidimensional NMR does away with the need to construct complete rested phase cycles. Hardware requirements of a phase-shifter are avoided. The scheme allows not only two-dimensional work but extrapolation to three and higher dimensional experimentation as well. A device for the measurements featuring a single, modern and ergonomic design has been developed and an international patent for `A novel device to detect Magnetic Resonance in Time Domain' has been filed.

### Superconducting microelectronic devices

It has been observed that cuprates are selectively highly sensitive to $NH_3$ and $NO_2$ in the temperature range of O°C to 50°C. Thus unlike conventional metal and metal oxide materials, cuprates are eminently suited for making room temperature gas sensors for detecting gases at low concentration (as low as 5 ppm).

CEERI prepared semiconducting YBCO films on $Si/SiO_2$ substrates, and superconducting films of YBCO and BSCCO on MgO and STO substrates, and tested them for gas sensing properties at Technical University, Ilmenau, Germany, using gases like $C_2H_6$ $CO_2$ CO, $CH_4$, $C_3H_8$, $H_2$, $NH_3$, NO and $NO_2$. Patents covering the work have been filed in India and Germany.

## TECHNOLOGY

### Atomic Force Microscope (AFM)

AFM is rapidly emerging as an important analytical tool for topographic studies of surfaces from micrometer to nanometer scale which has become important due to the recent advances in nanotechnology. As a versatile characterisation tool, the AFM finds numerous applications in quality control in the optical, semiconductor, magnetic recording and optical disk stampers industries. CSIO has developed an AFM which is modular, simple in operation and the components can be arranged to calibrate both the z displacements of the piezo and the voltage-to-distance responsivity of the detector, which are needed in addition to the cantilever spring constant for accurate force determination between the tip and surface. Using the AFM developed, CSIO has successfully imaged holographic gratings, micromachined surfaces and some biological molecules. Efforts are being made to license the design know-how to industry for commercialisation.

### Fabrication of GaAs power FET's

GaAs Power MESFET are used in high power amplifiers as a microwave source in satellite communication. Small size, low weight GaAs MESFET with an output power of 1 watt at 2 GHz. have been fabricated at CEERI and tested at SAC, Ahmedabad.

### PWM Actuating Amplifier

A pulse width modulated amplifier and control electronics for position control of an electromagnetic actuator has been developed by CEERI for Aeronautical Development Establishment. A batch of five actuators has been delivered to the sponsor. It can be used for position control in underwater, air borne vehicles, CNC machines, robotics, etc.

### 5 MW S-band Klystron tube

CEERI has successfully assembled the first prototype of the indigenous 5 MW S-band Klystron tube. This tube, excluding the magnet, weighs about 50 kg and is 1.2 meters long. The gun collector test module, a device to evaluate the design of the electron gun and collector, was successfully tested for the rated voltage of 126 KV at CAT, Indore. The tube is critical component for synchrotron radiation source (SRS) a national facility at CAT.

### Gain and phase matched mini TWT

A gain and phase matched mini TWT required for phased array radar system has been assembled, processed and tested by CEERI. The maximum output power achieved on the prototype is about 40 W in 4.5 - 13.5 Ghz frequency range and about 30 W in 15-18 Ghz frequency range under pulsed condition and about 40 dB gain in the frequency band from 4.5 Ghz to 18 Ghz. BEL has been identified as the production agency for the TWT.

### Teleclock

NPL has successfully developed a teleclock device for receiving and transmitting standard time in a master/slave configuration, in a telephone network. The system at present incorporates external modem and a built-in software to run the system for receiving/ transmitting standard time. This time signal could be that generated by a user in his own premises traced to NPL standard time by using an appropriate code and by dialling on a normal telephone. The device is being miniaturised for installing in any telephone instrument.

### PC based Hindi speech synthesis system

A high quality speech synthesis system, useful for the visually handicapped persons as a `reading' machine, has been developed by CEERI. As speech synthesis systems are language dependent, systems developed elsewhere in the world cannot be directly adopted for Indian languages. The system developed by CEERI is a high quality PC-based parametric speech synthesis system for Hindi using the cascade/parallel format synthesis model. The technology is being extended to synthesise other Indian languages, as well. It can also be used for other applications like information retrieval in railways/airlines/tourism industry and toys with voice synthesis.

### Electromagnetic soil salinity testing system

Soil salinity measurements are of prime importance in agricultural practices. An inductive electromagnetic (EM) soil salinity testing system developed by CSIO is an improvement over the digital soil salinity tester based on electrode technique developed earlier by the institute. Employing the EM technique for determination of soil salinity and electrolytic conductivity, the system dispenses with the use of conventional electrode salinity probes for the purpose and thus enables quicker, easier and continuous reading along a transection. The system

facilitates data generation for classification of saline soils and to study soil and water dynamics in irrigated agriculture. Applicability of the system in exploration of water resources is being undertaken in collaboration with agricultural universities.

### Ophthalmoscope and otoscope diagnostics kit

The diagnostic set essentially consists of Ophthalmoscope and Otoscope Heads employing halogen lamp and fiber optics. The heads can be quickly coupled to a power handle as required for examination of either the eye or the ear. Salient features of the kit developed at CSIO include small and large apertures for fundus examination through undilated or dilated pupil; graticule for measuring eccentric fixation and/or mapping of lesions in eyes, out of sight lens-ended halogen lamp coupled with fiber optic annular light carrier for bright and unobstructed viewing of the auditory canal and tympanic membrane; sealed system for pneumatic testing of tympanic membrane, etc. Know-how for the kit has been licensed for commercial production.

### Automobile exhaust monitor

Under sponsorship from the Petroleum Conservation Research Association (PCRA), New Delhi CSIO has developed an opto-electronic smoke density monitor for monitoring automobile exhaust. Designed to monitor the exhaust released from diesel operated vehicles in the free acceleration mode and also during various load conditions, the instrument is based on the principle of direct absorption of light and measures the percentage of smoke & carbon particles released from the exhaust.

### Industrial gas analyser

A PC based electrochemical gas analyser has been developed by CSIO for measuring high concentration of $SO_2$ gas in process gas-streams. The instrument employs a specially developed aqueous electrolyte that enables continuous on-line measurements of gaseous streams including highly moisturised areas unlike the currently used $SO_2$ analysers using pyridine based non-aqueous electrolyte. With slight modifications in electrolyte together with the instrumentation, it can be extended for the detection of other reducing gases such as $H_2S$ as well.

### Impact tester

A portable impact tester has been developed by CRRI to measure CBR value of soil in field. The impact tester enables to obtain large number of CBR values in a very short time. The tester consists of a compaction hammer equipped with an accelerometer which is connected to a digital electronic device. The hammer measures the strength of soil subgrade through dynamic impact value. The know-how has been licensed to industry for commercial production.

## HUMAN RESOURCES DEVELOPMENT

### Training in on-line instrumentation systems

CEERI conducted an international training workshop on the application of on-line instrumentation in pulp, paper, leather and food processing industries in February 1997. Representatives from UK, Finland, Austria, China and Republic of Korea participated.

### Training in instrument technology

CSIO contributes significantly to producing well trained instrument technologists through its Indo-Swiss Training Centre. During the year 1996-97, 40 students passed out of the three

year diploma course in instrument technology, 14 in the one year course for post diploma in industrial electronics and 20 in the four year course for advanced diploma in die & mould making.

Also a 4 year advanced diploma in mechatronics and industrial automation has been started w.e.f. July 1996 by upgrading the existing one year post diploma course in industrial electronics which has been recognised by the All India Council for Technical Education (AICTE).

### Management development programme for biomedical equipment

The fourth international management development programme on operation, maintenance and repair of biomedical equipment was conducted by CSIO at Delhi, Jaipur and Chandigarh between October and December 1996 for third world countries. The 8-week programme attended by 33 international delegates from 16 countries was sponsored by the MEA , Govt. of India under the ITEC/SCAAP programme.

### India-EU training programme

CSIO organised a training programme at Chennai on instrumentation and control systems for controlling energy costs under India-European Union Energy Management Cooperation Programme. Two experts from Europe acted as faculty alongwith other specialists. There were 20 participants comprising scientists, engineers and managers, mostly from industry.

### Training in repair & maintenance of basic medical equipment

A training programme sponsored by UNICEF, on repair and maintenance of basic health equipment for personnel of medical and health services from Rajasthan, Madhya Pradesh and Gujarat was conducted at CSIO S&M Centre, Jaipur during October & November 1996. Theoretical and practical training was imparted on various types of basic medical equipment to 19 participants.

### Winter school on atomic force microscopy

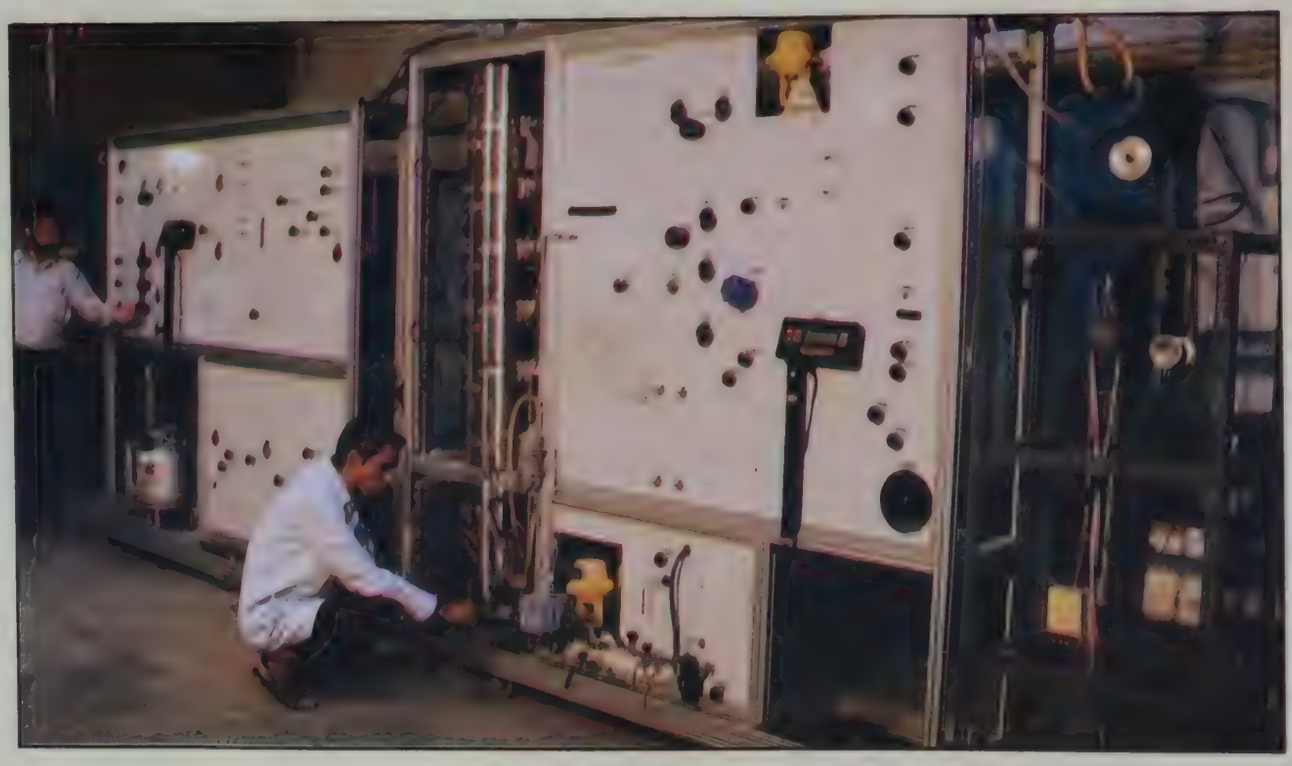
A winter school on atomic force microscopy was organised by CSIO in February 1997 under DST sponsorship. Scientists from various laboratories and universities participated. The participants were exposed to the latest characterisation techniques of atomic force microscopy through lectures and practical demonstrations.

## RECOGNITION & AWARDS

| | |
|---|---|
| National Science Academy Homi Jahangir Bhabha Medal (1996) | Narlikar, Dr AV (NPL) |
| Fellow of IEEE (USA) | Singh, Dr VR (NPL) |

# Energy

Low temperature electrolysis cell for aluminium production.



Catalytic reformer pilot plant at IIP.

CSIR laboratories have contributed new insight on the characteristics of Indian coals and in developing newer methods for coal mining.

## SCIENCE

### Basic studies on coal

CFRI continued basic studies on coal characterisation in which more than sixty different types of analytical data obtained from six different coals (out of eleven to be studied), prima facie reveal the significance of some important parameters like aliphatic content, type of vitrinite content, data on oxygen adsorption isotherm etc. relevant to the objective.

A method for measuring the degree of oxidation in coal sample (important for assessing coal for its proneness to auto-oxidation) is under progress. Also behaviour of coal related to its physico-chemical make-up, petro-graphic composition and mineral association is being studied for six different coals along with their petrographic components separately. An image analyser with matching software is being used in the study.

Using the software on molecular modelling density and charge distribution in the coal model earlier suggested by CFRI is being worked out.

### Processing of heavy residue

Study at CFRI on the solvent optimization and effect of pressure in heavy crude processing showed an evidence of higher conversion in the product (<600°C) with the solvent dosing upto an optimum level, while pressure has practically little effect on the conversion. On the basis of the data from batch experiments a continuous reactor system has been designed and order placed for fabrication.

### Low temperature aluminium-electrolysis

Currently aluminium is produced by electrolysis in cells operating at high temperature around 960°C due to high melting point of cryolite in the cell feed which account for about 50% of energy used in the manufacture of aluminium. CECRI is developing a process wherein cells are operatable at a lower temperature of 860-870°C, thereby saving considerable amount of energy.

### Structural characteristics of chemisorbed films of lubricating additives

Energy efficient engine and automotive gear lubricants containing additives such as hydrocarbon, soluble sulfur, phosphorus and molybdenum derivatives of olefines, alcohols, fatty acids and alkyl phenols cause considerable fuel economy and prolong the service life of the engines, as the additives contribute to energy saving due to reduction in both friction & wear via formation of low energy antiwear and antifriction films of metal sulphides, phosphates and phosphomolybdates as a result of chemisorption of these derivatives on rubbing metallic surfaces.

Studies at IIP in this direction related to the reaction of iron powder with methyl recinoleate. Its sulfurised and phospho sulfurised derivatives clearly show that the films formed are several layers of complex organic compounds which contain large amounts of chemically bound iron, leading to vital scientific conclusion that a variety of strongly adsorbed organic species are formed as chemisorbed films of rubbing metallic surfaces under tribochemical conditions

whose quality has profound bearing on the wear and friction characteristics exhibited by these derivatives in hydrocarbon oil. Also the strength of C-OH, C-S, S-S, P-O-C, P-S-P bonds and reactivity of the secondary species formed have profound bearing on the chemical nature of films formed and their antiwear and antifriction properties.

### Influence of surface phenomena on the dewatering of fine clean coal

The economics of coal utilization are critically dependent on solid/liquid separation technology. As energy costs rise, the need for better and efficient solid/liquid separation practice is very important as from utility viewpoint, a 1% increase in moisture can offset a 4.5% decrease in ash content. In a study undertaken by RRL, Bhu cake moisture content from ultrafine clean coal has been reduced by nearly 5%. A direct correlation between the point of zero charge (PZC) with the surfactant solution/coal system has been worked out and moisture lowering in the filter cake have been made. The mechanism for dewatering aids has been elucidated.

Keeping in view the tonnages of coal fine treatment in coal preparation plants in India and the advantage of applying surfactant dewatering aids. The significance of this study is immense. Internationally, this concept has been well adopted for coal preparation.

## TECHNOLOGY

### Solid oxide fuel cell

Solid Oxide Fuel Cell (SOFC) is one of the most promising alternative devices for power generation from gaseous fuels like hydrogen, carbon monoxide, hydrocarbons, natural gas, bio-gas etc. It is essentially a high temperature electrochemical device consisting of all-ceramic components. An SOFC based power plant has an efficiency of around 60% compared to 25-28% for thermal power plants and is environment-friendly too. CGCRI has been engaged in developing this advanced and futuristic technology for the last few years.

The emphasis so far has been on the synthesis, characterisation and optimisation of the processing techniques for different material components used in this device. The techniques for fabrication of all the major components such as the electrolyte, cathode, anode, interconnect etc. have been standardised at laboratory scale. The institute is to take-up an inter-laboratory national programme on a mission mode to develop the technology for SOFC.

### Low cost CdTe solar modules

While solar photovoltaics have long been the best option for harnessing solar energy as a clean and abundant source of electrical energy, its wide spread use in large scale PV utilities has been hampered due to high costs. Industrial demonstration of low cost potential and manufacturing capability of CdTe based solar modules is first such step in India in this direction.

NPL has been working on developing commercial level technologies for various cell fabrication steps, researching on new concepts for high efficiency cells and developing new cell structures and materials. As a participant member of a consortium NPL has promoted pilot line manufacture of low cost polycrystalline CdTe solar cell modules.

The PACER supported project being implemented by a Pune based private industry is aimed to design and develop a process line for 700 kW annual production capacity to demonstrate its industrial viability. NPL is providing technical guidance, for development of certain process steps, process parameters optimsation, materials for solar cell contacts, techniques for encapsulation and also for reviewing international status to decide best economic option.

## Hydrodesulfurization of diesel and vacuum gas oil (VGO)

In many parts of the world sulfur level in the diesel fuel is being reduced to 500 ppm or less due to increasing environment concern and also demand for better quality fuel to improve engine performance. India, is to reduce the sulfur level in her diesel fuel to 0.25% wt by the year 1999 from the present level of 1.0% wt (0.5% wt for metropolitan cities). IIP had taken up R&D for development of catalyst and technology for hydrodesulfurization (HDS) of diesel and VGO under sponsorship of Centre for High Technology, New Delhi.

Hydrotreated VGO is also a better feed stock for FCC with many processing advantages. IIP has now developed few catalyst formulations which can reduce sulfur content to about 0.1% wt in the diesel oil. This will more than meet the BIS specification for diesel stipulated for the year 1999. Keeping in view the future requirements further developmental work is underway for catalyst improvement in order to obtain product with a sulfur level of 500 ppm or less. The catalyst developed by IIP may be used as a substitute in the HDS plants in the country. The catalyst and HDS technology also have export potential.

## Conversion of light naphtha/natural gas liquid (NGL) to LPG and high octane gasoline

NGL is available in plenty in the country and is a good source of liquified petroleum gas (LPG), an important domestic fuel which is perennially in short supply and it can also be converted to gasoline. The aromatic rich concentrate can also be a valuable source for production of benzene, toluene and xylenes which are major building blocks for petrochemicals.

IIP has developed a shape selective solid acid catalyst and technology for conversion of light naphtha/NGL to LPG and aromatics. The catalyst can be tailor made to maximize either LPG or aromatics to meet specific requirements. GAIL has now planned to set up a demonstration plant of 8000 TPA capacity based on IIP technology for LPG maximisation with an investment of Rs. 8 crores. IIP will supply the know-how and basic engineering package and will be involved in running this demo-plant along with GAIL.

## Technology for CNG operation of two-stroke engine powered three wheelers

IIP has developed a simple retrofit technology for conversion of two stroke engines of petrol/diesel run three wheelers to CNG operable engines. CNG engine is smooth, less noisy and about 50% cheaper than gasoline operated engines. The conversion technology features a separate oil pump lubrication system which sends right quality of oil for various speeds and load conditions.

A separate idling circuit causes smooth and stable idling and also makes subsequent starts on CNG easier. The dual-fuel capability has the advantage of either CNG or gasoline operation which adds to the operating range of the vehicle. The conversion technology is unique because so far no technology for CNG operation of three wheeler has been

commercially exploited. IIP has successfully demonstrated in Delhi the first CNG three wheeler of the country. GAIL has sponsored this development and will be a partner in licensing the technology.

### Chamber mining of coal

Chamber mining method for extraction of thick, steep and complex seams at Makum coalfiled of NEC has been developed by CMRI. The method overcomes the problem of exploitation due to extremely weak, fragile and highly disturbed formation. The method is expected to yield a production of 450 TPD from a panel, thus enhancing the recovery even under worst condition by over 60 percent.

### Goaf pillar method

A special method of extraction known as 'Goaf Pillar Method' as suggested by CMRI was adopted for caving developed pillars at Chinakuri mine of CEL to induce zero subsidence in the waterlogged seam above. The above method of extraction consists of leaving whole pillars judiciously in the goaf such that their safety factor should be 2 or more for long-term stability.

### Coal-water slurry as an alternative fuel

A single-step wet grinding process for the preparation of high concentration coal-water slurry (HCCS) as substitute fuel for retrofit oil fired appliances was developed and standardised at 30 kg/batch by CFRI. A study with coals from North-Eastern region of the country (e.g. Challange from Meghalaya and Ledo from Makum field in Assam) showed a distinct advantage of the single step wet grinding process over dry grinding in respect of milling time and slurry viscosity which are reduced by 20-25% and 25-30% respectively.

### Standardisation and coal quality monitoring of washery despatches

CFRI has undertaken to develop the 'quality infrastructure' and methodology at the washeries and also train the BCCL and SAIL personnel engaged in the work at the seven coking coal washeries. The infrastructure has been improved at all the washeries. Efforts have resulted in considerable improvement in the quality of washed coal in general compared to the quality of washed coal produced earlier. As a consequence of quality improvement of washed coal, SAIL is likely to reduce import of coal by 5%. It is expected that the services of CFRI will be extended also to the washeries of CCL, Ranchi.

## SERVICES

### Technical services to Indian refineries

IIP engineers participated in precommissioning & start up of plants for pyrolysis gasoline hydrogenation, naphtha pretreater for a catalytic reformer, re-generation of reforming catalyst RG-451 and start up of a reformer plant. The technologies for these plants were co-licensed with IFP.

### Evaluation of products & devices in IC engines

IIP has comprehensive facilities for providing technical services for evaluation of fuels and lubricants as well as devices for conservation of these products. These services are regularly rendered by IIP either on its own or under sponsorship from PCRA, MNES, MOEF etc. Major

evaluation work carried out by the institute during the year were for performance evaluation of engine oil filter, super power device; industrial lubricants; evaluation of LPG saving device; four ball wear tests on gear oil formulation; CNG kit on ambassador car for road-worthiness as per Motor Vehicles Act; emission measurement of Eicher engines; certification of engine oils against BIS standards and field studies for 2T oil formulation on Bajaj Super Excel Scooters.

### Characterisation of crudes and products

One of the major support services provided by IIP not only to industry but also to various ongoing R&D projects is the physico-chemical characterisation of crudes and products. Major jobs carried out during the year included detailed evaluation of Panna & Mukta crude oils; short assay for pricing of the crude oils produced by joint venture companies; analysis of naphtha samples (imported & Bombay High origin) for fuel quality; characterisation of gasoline samples for their stability behaviour; feasibility for utilization of kerosene cut from Hazira Natural Gas Liquid (NGL) and characterization of pyrolysis gasoline from gas cracker.

### Modernisation of Coal washery

CFRI has successfully modernised the laboratory of BCCL at Dugda Washery. Efforts are underway to bring the laboratory in conformity to ISO requirement.

### Technical audit of tar acid recovery units and gas retorts

With a view to optimising the production of tar acids and subsequently upgrade the quality of saleable fine chemicals and high boiling tar acids (HBTA), a technical audit was undertaken by CFRI at Dankuni Coal complex. The audit helped to achieve qualitative improvement in the production of saleable fine chemicals viz., phenol, o-cresol, m&p-cresols and xylenols. In addition to manpower management, energy saving modifications have been suggested for increasing the net annual earnings by nearly Rs. 10 lakhs.

### Stability assessment of different townships at Jharia coalfield

In view of danger from underground workings and underground fire to various unsafe dwellings, stability status of different townships of Govindpur, Katras, Katras project, Sijua, Mohuda and Kusunda areas of BCCL was assessed by CMRI to identify and demarcate inhabited areas situated over unstable ground and overlying underground workings. A report was prepared and sent to BCCL for implementation of the recommendations.

## HUMAN RESOURCES DEVELOPMENT

### Training of petroleum personnel

IIP conducted 10 training programmes on various topics relating to refining technology and analytical techniques in respect of petroleum and petrochemicals, application of fuels and lubricants and measurement of automotive emissions. The programme had 206 participants from the oil industry and State transport departments. The training modules included advanced programmes on petroleum-related subjects for the senior executives from the oil industry.

### Technical training in mining

CMRI organised a number of workshops/technical courses in the area of mining. These were:

- A five-day course on Mine Inundation, Erosion and Preventive Management organised during Sept.-Oct. 1996, aimed at an effective management system to prevent accidents due to inundation in coal mines. More than 20 participants attended the course. That safety audit, not only in emergency but also as a matter of routine practice at regular intervals, is a must, was an important aspect emphasised.
- A one-day workshop on recent advances in rock blasting organised by CMRI regional centre at Nagpur in Sept. 1996 stressed the need for implementation of the latest technological developments in routine blasting. A large number of participants attended the workshop.
- Second national conference on ground control in mining at Calcutta in Oct. 1996 acquainted the participants about the contributions of CMRI in the field of ground control in mining with special reference to the work done in the field of roof and cable bolting, longwall mining and applications of numerical modelling for solving ground control problems.
- Seminar on 'prevention and control of mine fire-trends and challenges (MIF'96)' in Calcutta in Dec. 1996. About 100 delegates attended the seminar.

### Workshop on air quality modelling and atmospheric acidification

A week-long training workshop on air quality modelling and atmospheric acidification was conducted at CMRI in November, 1996, under project CREN of the CSC, UK. The workshop was attended by the participants from UK, Australia, Vietnam, Bangladesh, India, Malaysia and Sri Lanka.

## RECOGNITION & AWARDS

| | |
|---|---|
| Kamal Kumari National Award for Science and Technology (1995) | Prasada Rao, Dr TSR (IIP) |
| Catalysis Society of India Eminent Scientist Award (1996) | Prasada Rao, Dr TSR (IIP) |
| Shri Om Prakash Bhasin Award in Science and Technology (1997) | Prasada Rao, Dr TSR (IIP) |

# Environment & Ecology

Mitigation of pollution due to foundry emissions (left) general view of the ducting cyclone and chimney of gas clearing system for cupolas and (right) installation of the explosion cap of the pollution control system on the cupola

High rate biomethanation plant for treatment of waste waters (inset) the plant at night illuminated by biogas lamps.

CSIR has been assisting the judiciary as an independent assessor of diverse environmental issues and as an inspector of cases on compliance with judicial pronouncements. Besides CSIR has been concerned with issues of green house gas emissions and carrying capacity of critical regions. Through all these activities CSIR has been doing its bit in assisting the industry mitigate its environmental pollution problems.

## SCIENCE

### The Asia Least-cost Greenhouse Gas Abatement Strategy (ALGAS)

The ALGAS project being implemented by the Alternate Energy Development, Inc., with funding from Asian Development Bank aims at assisting 12 participating countries from the Asian region to reduce the rate of growth in their emissions of green house gases (GHG). The ALGAS-India National Work Plan for the preparation of nation at GHG inventories is being carried out by the NPL. Two of the three national technical experts identified in the areas of `Emissions from Energy and Industrial Processes' and `Emissions from Agriculture' are from NPL.

### Indian Deep Sea Experiment (INDEX)

The INDEX project was initiated by NIO, in 1995 to assess the environment impact on the marine ecosystem due to seabed mining in the central Indian ocean basin (CIOB). Geological, biological, physical and chemical studies were undertaken to establish the baseline conditions in the area. Close grid bathymetric surveys and analysis of nodules have led to the identification of test and reference areas. Detailed geochemical, sedimentological, stratigraphic and geotechnical studies conducted on sediments, enabled understanding of the benthic conditions, besides the distribution of macro-, meio- and micro- fauna. Analysis of baseline data on ocean currents indicate variability in the flow field, variation in the thickness of upper oceanic mixed layer and a decrease in surface salinity towards the southwest part of the CIOB. Biological studies revealed that the euphonic zone of the CIOB has fairly rich and diverse fauna.

## TECHNOLOGY

### Industrial complexes for phospho-gypsum fertilizer waste problem

Under a study sponsored by the US National Science Foundation, NEERI, in collaboration with the Clean Energy Research Institute, Florida, is to examine the feasibility of locating and operating an industrial complex comprising phosphatic fertilizer and cement plants within an Environmentally Balanced Industrial Complex (EBIC) at one site in India. Investigations on beneficiation requirements for phosphogypsum and/or phosphochalk, cost of cement production, and the quality of cement which govern the willingness of cement manufacturers to shift from limestone to byproduct phosphogypsum (BPG) as a calcium source are among the major factors for study. The beneficiation study revealed that the fluoride, sulphate and phosphate concentrations can be reduced to levels permitting cost-effective usage of beneficiated phosphochalk for ordinary portland cement (OPC) and masonry cement manufacture. The wastewater generated during the beneficiation is treatable, and would meet the regulatory standards with recourse to available wastewater treatment processes.

### Modernisation of coke based cupola for foundries

World over the foundry industry has been under pressure to mitigate environmental pollution due to cupola emissions. The situation in India is no different since majority of the cupolas in the country use coke as fuel. The emissions from such cupolas have been found to contain suspended particulate matters (SPM) and $SO_x$ at levels much higher than the acceptable levels recommended under the CPCB stipulations which are 150 mg /$m^3$ for SPM and 300 mg/$m^3$ for $SO_x$. Following the Supreme Court's stipulation that the existing

foundries take appropriate action to reduce the environmental pollution level to the acceptable levels as recommended by CPCB within a specific dateline, NML took up design & development of :

- **Gas cleaning system :** a cost-effective dry gas cleaning system for various cupola sizes ranging from 2 to 25 tonnes/hr capacities. Demonstration units set up at two foundries in the districts of Howrah, provided encouraging results. NML then took up the work of conversion and installation of gas cleaning system for cupolas of different sizes for industries. The project was taken up on turnkey basis and was valued at Rs. 144 lakh. NML completed the assignment within a period of six months and met with the CPCB norms and the dateline. The gas cleaning system developed by NML being of a dry type is cost effective.
- **Cokeless cupola:** environment friendly cokeless cupola using liquid fuel or almost sulphur free natural gas/LPG which not only reduces the SPM but also brings down the emission due to sulphur dioxide within the stipulated limit of 300 mg/$m^3$. The development of total technology package for cokeless cupola was undertaken under financial sponsorship from TIFAC. The NML cokeless cupola has very low pollution, low capital and maintenance cost, easy and better process control system and gives excellent quality iron.

### High rate biomethanation system at RRL, Bhu

NEERI has designed, constructed and commissioned at RRL, Bhu a 400$m^3$/day capacity high rate biomethanation plant based on the fixed film-fixed bed reactor technology developed at the Institute. The fixed film system uses microbial film as a means of achieving high mean cell residence time (MCRT) independent of hydraulic retention time (HRT), thereby achieving cost-effective designs. Compared to the conventional anaerobic treatment, where the MCRT is rarely greater than twice the HRT, fixed film processes achieve MCRTs of the order of 10 to 100 times the HRT. In addition, high system efficiency is maintained over a wide range of organic loadings. The biomethanation plant was jointly financed by the MNES, Government of Orissa and RRL, Bhu.

### CETPs for industrial estates of NCT-Delhi

The Delhi Pollution Control Committee (DPCC) retained NEERI to design and assist in installation of common effluent treatment plants (CETPs) in twenty-eight industrial estates in NCT-Delhi. The institute conducted extensive field investigations in the industrial estates to assess techno-economic feasibility of CETP installation and keeping in view the reuse and recycle potential of treated wastewater for process usage, the treatment options have been evaluated with suitable physico-chemical, and biological routes. Treatment options have been ranked by salient attributes such as effluent characteristics, annualised costs, reuse potential, land requirements, and process reliability to arrive at the most appropriate alternative for each CETP. The total capital cost of fourteen CETPs for a reusable treated water quality is estimated at Rs.90 crores with an annual O&M cost of Rs. 48 crores. The cost of treated water ranges from Rs. 5.93 to 16.05 per $m^3$, which is on par with the cost of municipal water supply in NCT- Delhi for industrial usage.

### Wastewater renovation with recourse to Soil Aquifer Treatment (SAT) system

The SAT system involves wastewater renovation by infiltration through soil matrix. Under a project sponsored by the Ministry of Water Resources, NEERI in collaboration with the PRL, Ahmedabad and the Ahmedabad Municipal Corporation, conducted controlled experiments with primary settled sewage under different experimental conditions to assess the wastewater renovation efficacy of soil matrix with reference to filtration, adsorption, ion exchange and biodegradation. A 500 $M^3$/day pilot plant was operated under varying experimental conditions of sewage inflow rate and flooding/drying cycles to assess the efficacy of the natural riverbed

on the removal of suspended solids, BOD, COD nitrogen, phosphate, and bacteriological characteristics. The results established the feasibility and efficacy of the SAT system under the prevailing climatic and physical conditions at the Sabarmati river bed in Ahmedabad. A mathematical model has been developed, calibrated and validated to enable wider application of SAT system in India.

## SERVICES

### Environment impact assessment (EIA) and environment audit studies

RRL, Bho has taken up some important environmental studies. These are:

- **EIA for LPG storage facility :** comprising characterisation of the status of the environment in an area of 10 km. radius from the project site for identified environment components viz., air, water, land, biological environment, noise and socio-economic environment for the first private gas company with LPG storage facility for 1,20,000 MT per annum at Port of Porbander. LPG is imported as a mixture of commercial propane and butane in pressurised tankers by the company for transmission to bottling units cross the country.
- **EIA for proposed leather complex in MP :** preparation of rapid EIA incorporating one season data and comprehensive EIA incorporating three seasons data is under progress at the proposed leather complex at Pipalkhedia in Raisen district of Madhya Pradesh. The site is selected for setting up all the wet processes including tanneried gelatine, glue etc, while the another site at Adampur will cater to all the dry processes viz., marketing, finished products etc.
- **EI & RA of proposed floating hotel at Bandra coast, Mumbai :** environmental impact and risk assessment at present and the impact on it after the speciality restaurant cum hotel is established on board the stranded ship M.V. Zhen Don, off Carter Road, Bandra Sea Face, Mumbai are to be conducted. One season monitoring for air, soil, water and biological parameters has been carried out.
- **Rapid and comprehensive EI & RA for proposed 120 MW Gas Turbine based power plant at Marmugao, Goa :** EIA studies for the project of a private industry involve preparation of rapid EIA report covering one seasons monitoring and comprehensive environmental impact assessment report covering three season monitoring for different environmental components based on MOEF guidelines. One season monitoring for air, water, land and environment has been completed successfully and studies related to other components of environment such as biological, socio-economic is under progress.
- **Environmental audit studies for urea and ammonia plant :** for a major fertilizer producing industry with various unit operations/processing operation during the production. Environmental audit to establish and maintain whether or not environmental management activities conform to the environmental management programme and are implemented effectively and to conduct material, water, environmental quality, health and safety studies to identify avenues for saving in the costs of production and to arrive at possible options for reduction in use of hazardous wastes and recycle/reuse of effluents. Pre-audit and onsite audit phases have been completed and post audit phase which includes finalisation is under progress.

### Environmental impact and risk assessment (EIRA), environmental audit (EA) and carrying capacity studies

NEERI completed twenty six EIRA & EA studies during 1996-97 for oil exploration and petroleum industry, mining sector and associated industries, thermal power projects, water resources projects, tourist resorts and hazardous wastes disposal sites. The carrying capacity based planning studies for sustainable socio-economic development in Doon valley and

National Capital Region with the sponsorship of the Ministry of Environment and Forests have also been completed thereby delineating alternate routes to sustainable economic growth with equitable quality of life.

### Environmental management systems for the judiciary

NEERI submitted twenty-eight inspection reports during 1996-97 on environmental management systems in Andhra Pradesh, Goa, Gujarat, Haryana, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Tamil Nadu, Uttar Pradesh and West Bengal to the Hon'ble Supreme Court and the High Courts of Andhra Pradesh, Gujrat, Himachal Pradesh, and Madhya Pradesh. These pertained to inspection of mines, water supply and sewage disposal systems effluent treatment plants environment protection and pollution control measures among other issues.

### Recovery of iodine from drug industry effluent

CSMCRI, on request from a drug company successfully demonstrated at the plant site an effective technique for recovery of elemental iodine from effluents of their process for a drug involving iodine as an intermediate and also for dehydrating the recovered iodine to obtain iodine of more than 99% purity. Taken up on consultancy basis, the job involved recovery of iodine present in the different oxidation states viz +1 and -1 in acid and basic streams respectively of the effluent. The technique developed ensured the non-interference of the phenolic and carboxylic acid functional groups present as organic matter in the effluent.

### Performance evaluation of wastewater treatment plant of Chandigarh

CSIO undertook performance evaluation of waste water treatment plant of Chandigarh for the S&T Council, Chandigarh administration. The performance evaluation of primary, secondary and tertiary treatment plants was critically examined and evaluated to assess the suitability of this water for irrigation after recycling and treatment. Various chemical, physical and biological parameters have been monitored and recommendations to improve the various operational procedures and plant performance have been made so as to preserve the ecology. This technical service has greatly helped improve the bio-diversity system & waste water management of Chandigarh.

## HUMAN RESOURCES DEVELOPMENT

### Indo-British training in environment impact etc.

NEERI organised an Indo-British training programme sponsored by the British Council during March, 1997 at Nagpur on environmental impact and risk assessment & environmental audit for fertiliser industry. Twenty three participants attended this programme.

### Training programmes on societal sanitation system

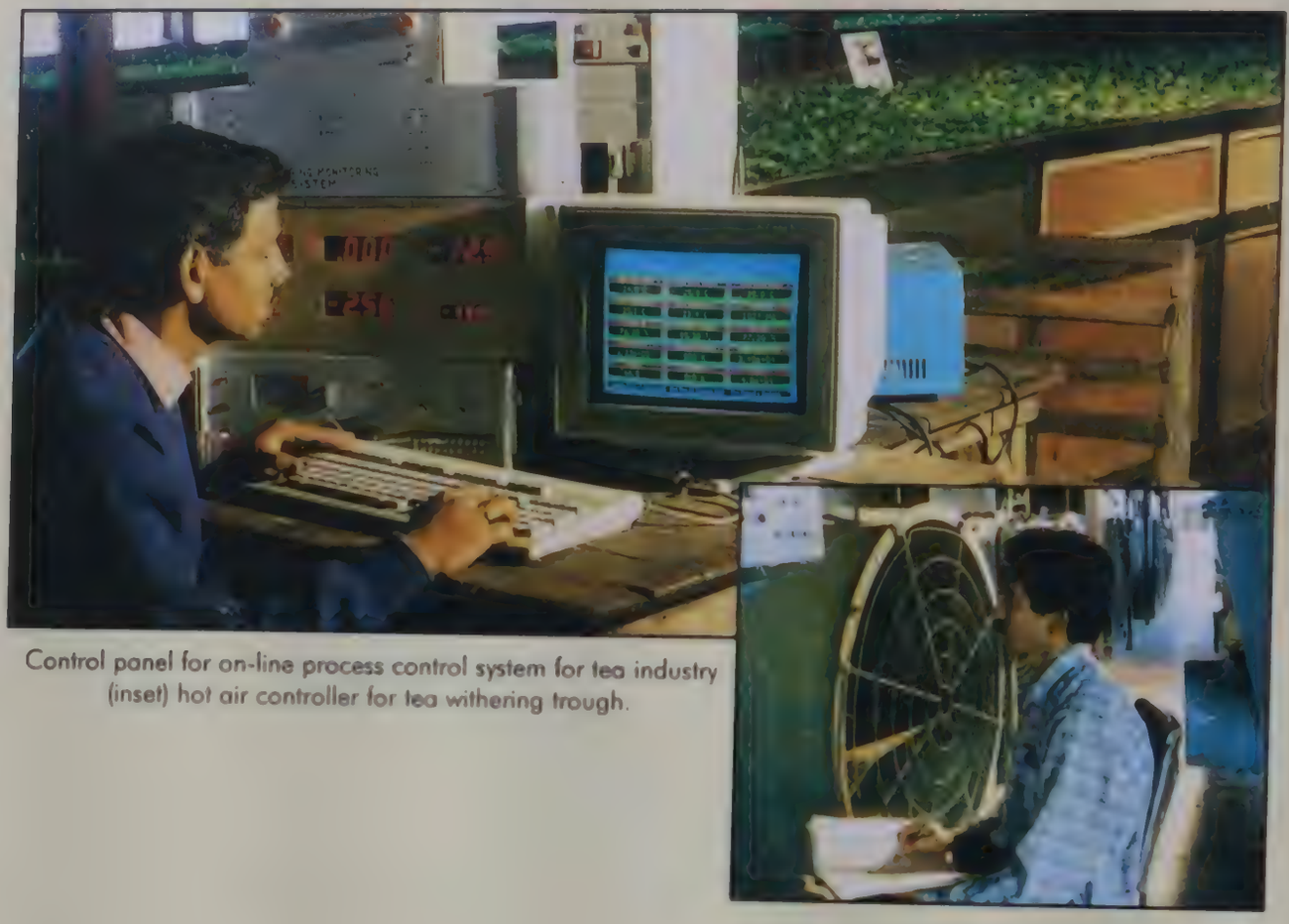
NEERI organised the following two training programmes:

- on environmental audit for fertiliser industry, on construction of pour flush water seal two pit latrines, sponsored by the Bharatiya Adimjati Sevak Sangh at Gadchiroli, Maharashtra during May, 1996. Thirty participants were trained in this programme.
- on construction of washing platform with a soakage pit, sponsored by the National Institute of Women, Child & Youth Development, Nagpur at Wardha, Maharashtra, during January, 1997. Twenty participants were trained in this programme.

### Training in pollution control methods

ITRC organised a one week training course on standard methods employed in pollution control activity for 20 newly recruited technical persons of UP Pollution Control Board.

# Food & Food Processing



Control panel for on-line process control system for tea industry (inset) hot air controller for tea withering trough.

Automatic idli making machine

CSIR's efforts in food processing have been threefold namely : (a) to develop cost effective value addition processes for cereals and pulses, (b) to enhance the value, transportability and shelf-life of fruits, vegetables and spices, and (c) to improve food safety. Towards these objectives CFTRI and Regional Research Laboratories at Jammu and Trivandrum continued their endeavours.

## SCIENCE

### Migration in plastics

The effects of time and temperature on the amount of migration of additives from Polyethylene terephthalate (PET) was studied along with different food simulates, such as distilled water, 3% acetic acid and 50% ethanol. The amount of extractives leaching at different temperatures ranging from 30 to 70°C have been estimated in the migration studies for time intervals ranging from 1 hour to 30 days.

It is observed that the quantity of extractive is proportional to square root of time (t) upto 70% extraction. Also the extractives increased exponentially with temperature for all the food simulating solvents. For the different food simulates, the maximum extractive value was reached in 25-30 days at 30°C and in 6-12 days at 70°C.

### Retarding autoxidation in raw peanut oil

CFTRI in studies directed towards retarding antioxidation in raw peanut oil observed for the first time the synergistic-antioxidant effect of the phospholipid gums-water combination in raw groundnut oil.

The studies indicated that the stability of the oil could be improved by the addition of about 0.2% water to raw groundnut oil, enhancing its shelf-life. The importance of moisture content in imparting oxidative stability to raw groundnut oil may hold good for other unrefined vegetable oils also. This observance of the phenomenon has opened up avenues on use of phospholipids as natural food additives.

The powerful antioxidant properties shown by phospholipid gums and water combination indicate a possibility of free radical inhibition in biological systems such as membranes (in-vivo). Thus, the free radical inhibition may have health benefits.

## TECHNOLOGY

### Automatic idli maker

CFTRI has developed an automatic idli making machine that can steam out 1000-1200 idlis per hour. Idli, the south Indian breakfast speciality made by steaming small portions of fermented dough of rice and black gram in specific proportions, is now popular country-wide as a favourite food item.

The machine has automatic dispensing and scooping mechanisms and a CIP-washing system. It is useful for large scale production of idlis, such as in railways, industrial/defence/ departmental canteens, etc. The machine can be used for preparing products akin to idlis and also for other steam cooking purposes.

## Flavour of basmati rice

Two stabilised Basmati rice flavours were developed by CFTRI and bench scale processes standardised.

Basmati rice flavour was isolated using simultaneous distillation and extraction (SDE) method. The volatiles generated were trapped in a suitable medium, released subsequently and extracted with an organic solvent.

The flavour was separated into basic and non-basic fractions, which were analysed by GC-MS. The flavour-impact constituents were present in the basic portion, prominent among them being 2-acetyl-1-pyrroline. Mass spectral data could be obtained for fifteen other compounds. They were all related to heterocyclic compounds, having similar mass spectral fragmentation patterns. Subsequently 2-acetyl-1 pyrroline was synthesised from pyrrole as a 1% ethanolic solution.

For quantitation of basmati flavour, two methods were tried. First method involved the use of collidine as an internal standard for the estimation of 2-acetyl-1-pyrroline in Basmati flavour samples. The second method involved selected ion monitoring (SIM) on GC-MS in which peaks at 111, 83 and 68 were monitored. This, alongwith comparison of its Kovats index with that of the standard, enabled identification and quantitation. The SIM method afforded enhanced sensitivity of detection.

## Biodegradable packaging films from chitosan

Packaging films made out of proteins, polysaccharides and their derivatives are in use in the western countries and Japan as eco-friendly packaging material. Chitin is one of the abundantly available polysaccharides in nature, which India has in plenty. In R&D aimed at suitable chemical modification of chitin, CFTRI has come out with a number of applications. One modification is cross-linking, which gives thin (5-10 mm) transparent films.

The films prepared from the cross-linked chitosan were tough, and possessed excellent tensile/tear strength, both in dry and wet states and thus could be useful as wrapping material for packaging fruits, vegetables and processed foods. Know-how has been developed for chitosan films to replace plastic as food packaging materials for specific applications.

## On line process control for food industries

CEERI, had pioneered the modernisation of Indian process industries by introduction of on-line process control instrumentation leading to cost effective implementation of process technologies and production of high quality products. Instrumentation earlier developed for sugar industry have been successfully used by Indian industry resulting in appreciable savings in energy. CEERI has now introduced on-line control systems for tea and vegetable/fruit processing industries . These are:

- **Monitoring and control system for tea withering process :** the computer based withering process monitoring and control system developed senses on-line parameters of the leaf in the trough, estimates the percentage of withering and controls the fan and hot air supply to the trough.

The control system incorporates the heuristic knowledge and this in addition to the on-line data makes the decision on the status of the withering process. It is energy efficient giving 25% reduction in energy consumption and increases the throughput by reducing the withering time and enables production of consistent quality tea.

- **On-line brix monitoring sensor and system for tomato concentrates and pulps :** the system can be used to control the tomato concentrates and other similar products in food processing sector. The system is based on optoelectronic determination of critical angle for the medium of measurement in the range of 0-90 degree brix in three or four ranges. It is cost effective indigenous instrument for monitoring the most important parameter contributing to the quality of the product. Introduction of this automation leads to value addition to the agricultural products and the technology has great potential for export to third world countries.

  Primarily designed for processing of tomato and mango pulp concentrates, jams, juices, sauces/ketchup etc., it can also be used in other industries like, paper, pharmaceuticals etc. with slight modification in the sensor assembly and software.

### Isolation of piperine from pepper oleoresin

India is a major producer of pepper. Yet there is no commercially viable process for making piperine, the pungent active principle of pepper, which besides its food application also finds use in pharmaceutical preparations.

CFTRI has developed a method for treating the pepper oleoresin having 40-50% piperine by physical process to obtain enriched product having 80-85% piperine which by a solvent wash gives piperine of purity >96%. The process is ready for commercial exploitation. It is expected that the isolation of piperine from pepper will boost value addition and export earnings.

### A xylanolytic enzyme suitable for clarification of non-citrus fruit juice

A xylanolytic enzyme obtained from an edible fungus was used by IICB for clarification of apple and grape juices. The process does not require use of any filter-aid or vacuum filtration for clarification. An Indian patent application has been filed.

## SERVICES

### Analysis and testing of samples

Analysis and testing of different products and packaging materials, received from private and government organisations for physico-chemical attributes, nutritional quality and other specific analyses, were undertaken on over 1200 samples from nearly 570 parties by CFTRI.

### Technical assistance

Technical assistance was given by CFTRI to sixty parties by providing information on raw materials and technology for production of food products. CFTRI had technical discussions with nearly 3000 entrepreneurs and other interested parties from different states in India and abroad, on various aspects of food technology.

## HUMAN RESOURCES DEVELOPMENT

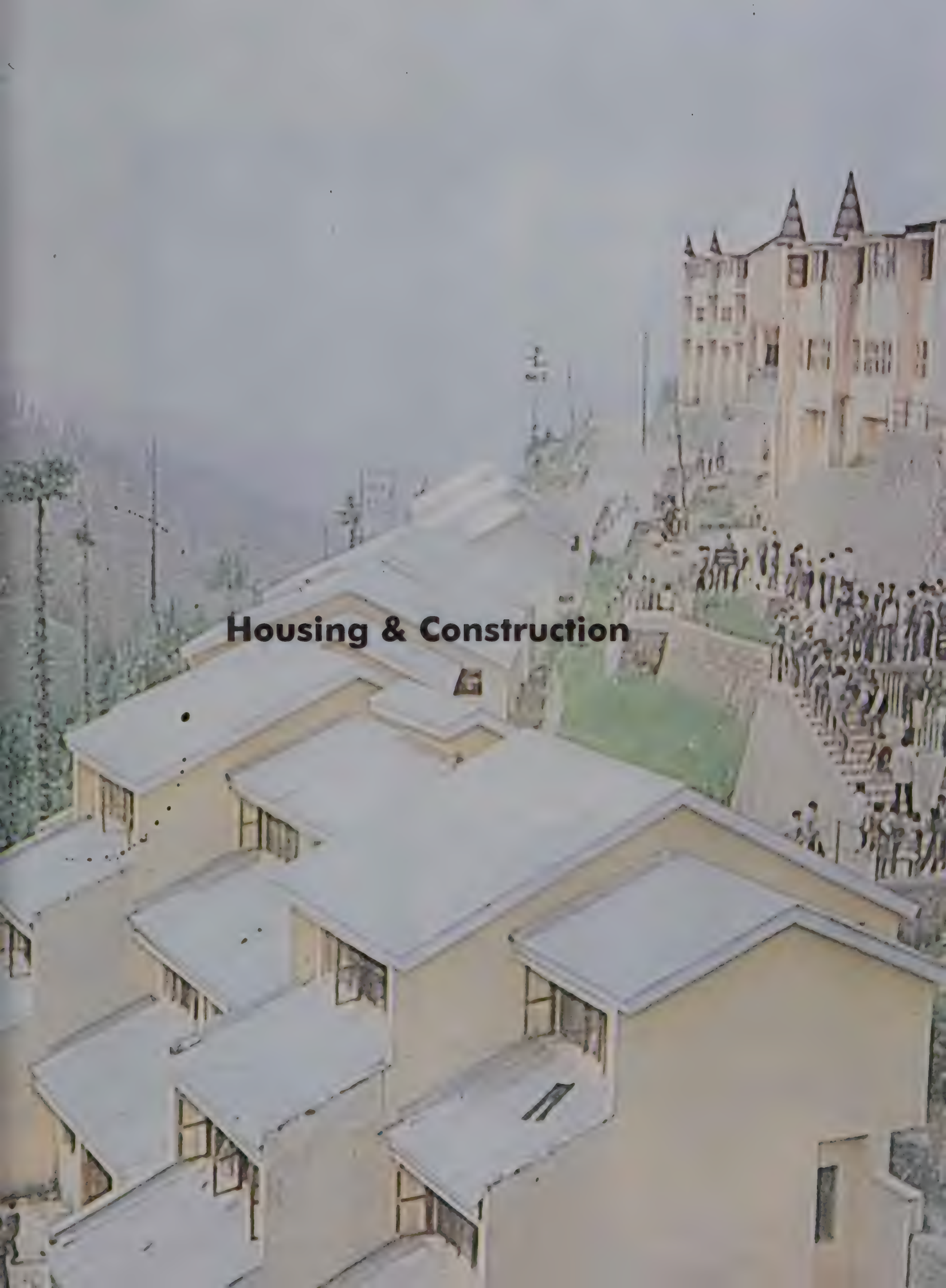
### Training courses in food processing and technology

CFTRI continued its regular programmes of academic and practical training courses in the area of food processing and technology, namely :

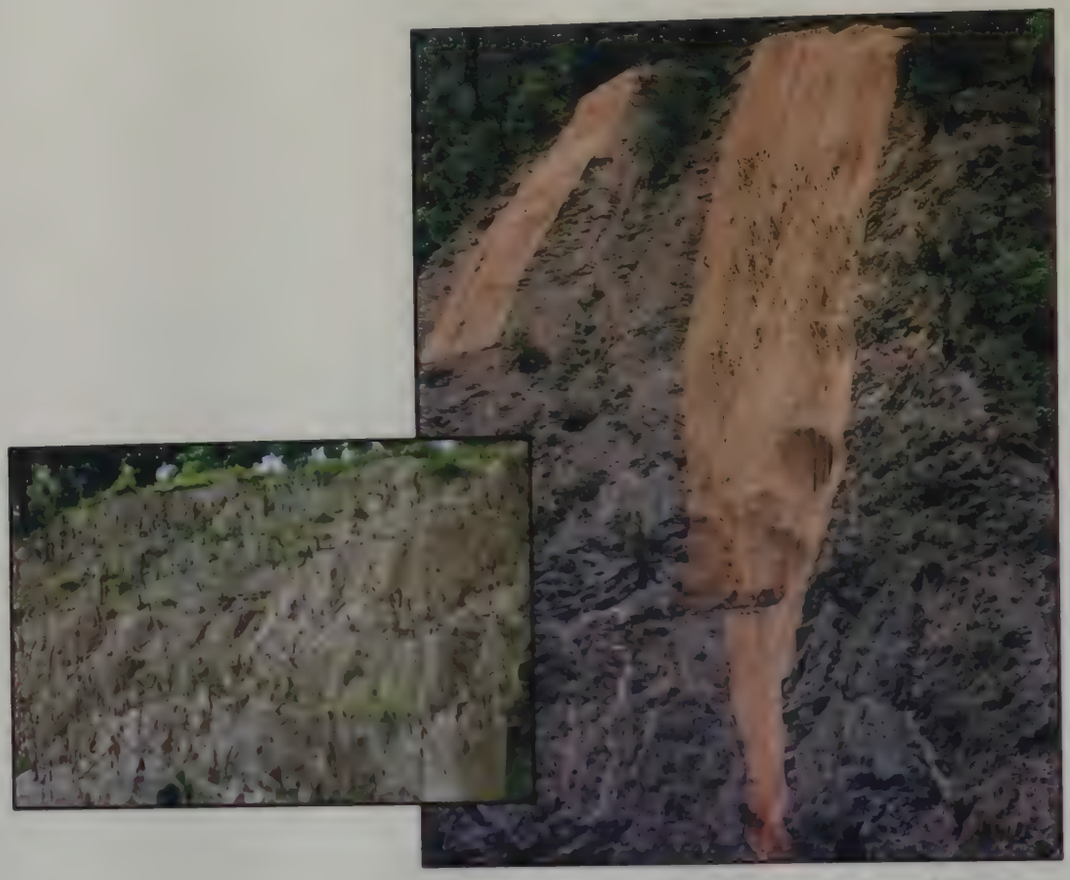
- Master's degree in food technology: fifty fresh graduates from food science and agriculture undertook the course. The uniqueness of the course lies in the involvement of the faculty of R&D departments and also infrastructure facilities of CFTRI in imparting an intense theoretical training coupled with practicals in state-of-art technology in food processing.
- Certificate course in milling technology : twenty one graduates took the ten month course. This course is the only one of its kind in the Asian region for training of professionals in flour milling. The students are exposed to the scientific and engineering principles of the art of flour milling with the help of sophisticated training mill of 25 tonnes per day capacity.
- Short term courses: in eighteen advanced level custom designed short term programmes, training was imparted to 435 participants from food industries with experience in production, quality control, management and marketing. These programmes are meant for retraining of the personnel under the United Nations University Programme. A few participants from developing countries also took the advanced level training in research and development.
- Six awareness programmes about the microbial contaminants and hazards and the need for purification of water for human consumption were conducted. These programmes attracted a total participation of about 500 persons from rural areas. One of the programmes was exclusively for women entrepreneurs and 95 women took part.

## RECOGNITION & AWARDS

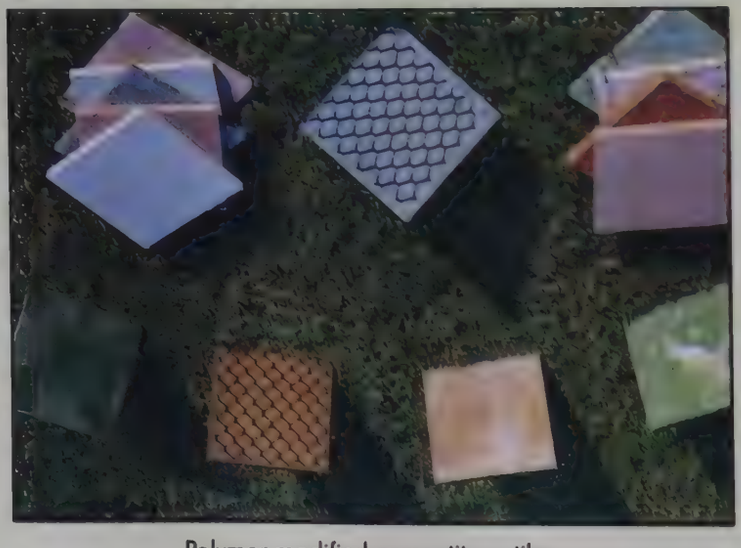
| | |
|---|---|
| Shanti Swaroop Bhatnagar Prize for Biological Sciences (1996) | Prakash, Dr V (CFTRI) |



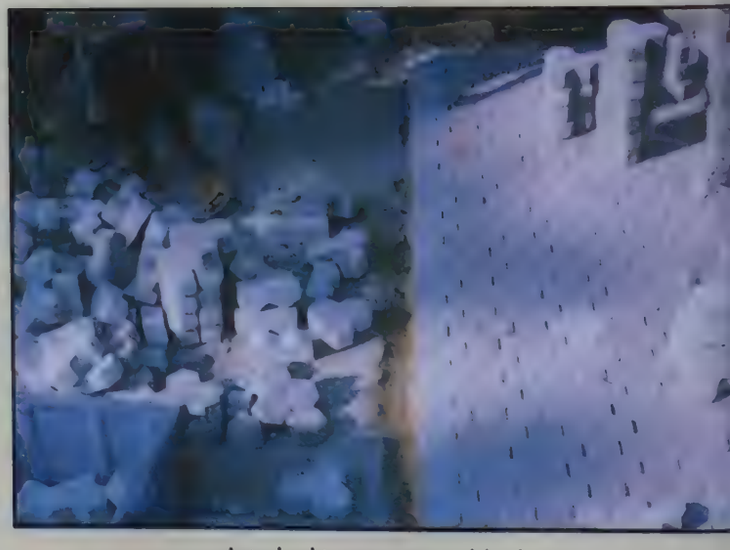
# Housing & Construction



Application of jute based geotextiles for stabilisation of landslide prone hilly areas (inset) shows vegetation on the stabilised portion.



Polymer modified cementitous tiles



Interlocking concrete blocks

Significant work on road construction materials, techniques and traffic management was contributed by CRRI besides study of structural integrity of specialised structures/structural components by SERC,M for different types of static and dynamic loads.

## SCIENCE

### Experimental and theoretical investigations on the behaviour of buildings under acoustic loads

At rocket satellite launch centres several buildings serve as control and service structures and are located close to the launch paid. Their design requires understanding the nature of forces acting on the buildings and the structural response. SERC,M accordingly carried out a study at the SHAR centre to study the acoustic pressure characteristics on the CTR building during the PSLV-D3 launch in March 1996.

As a result, a methodology to quantify the dynamic loads and an empirical expression for the acoustic loads on these buildings taking into account the spatial decay of the pressures could be established. Apart from assisting in developing design guidelines for acoustic-loaded buildings, the results have also contributed to methods for analysis of structures subjected to broad-banded pressure loading, such as the acoustic loading.

### Mathematical modeling for shock bearing structures

All important structures such as offshore, power plant, defence, and such other critical structures, which are vulnerable to accidents or attacks, have to be designed for survival against shock loads due to blast or other impacts. Research work in this area is of national importance and has become urgent. Usable information on this topic is not readily available in the open literature because of its strategic significance.

SERC,M initiated a project to improve the capabilities for analysis and design of shock-loaded structures by developing computational models and software for efficient non-linear transient dynamic analysis. Impact experiments on structural elements, such as beams were conducted based on which models of the elastoplastic behaviour and strain-rate influence relevant for concrete and steel developed alongwith computational procedures.

This has enabled the efficient and optimal design of shock-resistant structures. Extending these studies to composite-material structural elements may be of considerable interest in the future.

### Dynamic pile foundation soil interaction

SERC,M has formulated a method for the evaluation of the dynamic characteristics of group of pile foundation when subjected to either a vertical or horizontal oscillating load. Synthesising this method with the results of the dynamic characteristics of the superstructure in the frequency domain, it provides a solution to the pile-structure dynamic problem.

The program was validated through several numerical examples and experimental testing. A novel facility called Elastic Half Space Simulator was specially designed such that outgoing dynamic energy was completely absorbed with very little reflected energy from the boundaries. Using the facility, a computer parametric study was carried out experimentally varying the l/d and s/d ratios of different configurations of piles.

## Residual life of corrosion-affected reinforced concrete structures

SERC,M carried out a large number of laboratory experiments to study the parameters that influence corrosion and its effects on reinforced concrete structures. Based on the extensive data collected, relationships have been established for the required cover thickness for different diameter of reinforced bars to resist cracking due to corrosion.

A simple but reasonably acceptable methodology has been developed to predict the service life of corrosion prone structures and residual life of corrosion-affected structures.

## Jute based geotextiles

Under a project sponsored by UNDP studies have been carried out by CRRI on the use of jute based geotextiles in road construction and stabilisation of land slides prone hilly/ mountaineous areas. Field trails have been successfully completed at different locations for applications such as ground improvement at Kakinada port to tackle soft clay problems, for pavement drainage application at Joshimath-Mallari Road (SH-45) under DGBR area and as a filter in reinforced retained wall at Hanuman Setu, New Delhi.

Proposals have also been made to use jute based geotextiles at Kandla Port Trust as a separator between pavement layer to provide restraint, reinforcement and to prevent localised bearing capacity failures. At Kaliasaur jute geotextiles are being used for stabilisation of landslides.

## National study on rural roads

In collaboration with Asian Institute of Transport Development (AITD), New Delhi, CRRI has carried out a study to develop a systematic and integrated approach to various aspects concerning rural roads. It includes mobilization of additional resources, beneficiary participation, technology transfer, development of optimal standards to minimizing life cycle costs, human resource development, maintenance policies and management.

## Pre-feasibility study of National Highway-8, Delhi-Jaipur Section

At the instance of National Highway Authority of India (NHAI), a study has been undertaken by CRRI to develop a model National Highway with partial access control so that user car contribute toll tax. It includes location and type design of toll plazas, maintenance and management of integrated road side facilities, road plantation, road safety measures, highway patrolling, and law & order aspects.

## Parking study of selected areas in Delhi

At the request of Delhi Development Authority (DDA), CRRI carried out a study to assess the parking demands of different categories of residential and commercial areas and also to modify parking norms based on vehicle ownership rates in different colonies. On the basis of data collected through different surveys, models have been developed which were used for the assessment of future parking demand for 2001 and 2011.

Parking norms in equivalent car space (ECS) for different type of residential and commercial land use have been suggested which would work as a future guideline for the authority.

## High tensile bituminous mixes

Studies by CRRI have been carried out to develop high strength bituminous mixes by using mastic interlayer in combination with modified bituminous mixes to prevent reflection cracking due to high tensile stresses exerted by the action of repeated traffic. Test results indicated four to five times increase in resistance to fatigue.

## Wind climate studies for building designs

Knowledge of wind climate is of paramount importance for designing of buildings with respect to environmental and structural constructions. CBRI undertook extensive investigations on wind climate in India to evolve hitherto unavailable information on seasonal, inter-seasonal and inter-annual variability of wind data, which is useful for identification and regionalisation of homogeneous wind climatic zones for building designs.

Data on mean monthly wind speed for a period of fifty-nine years from 1931-90 from 120 stations spread all over the country were procured from IMD and analysed to determine the values of the annual average wind speed, standard deviation, skewness and kúrtosis for each of the stations and the data subjected to rigorous analysis using various multivariate statistical methods to study the variability of wind speed in space and time.

The results of all the intensive statistical analysis clearly depicted occurrence of 60 year's wind cycle in India. The findings have been corroborated by the Power Spectral Density functions which were also estimated using the above annual and seasonal average wind speeds.

## Seismic motion studies of Delhi region

CBRI has taken up a project to conduct indepth studies on the seismic motions in and around the Delhi region. The project aimed at understanding the attenuation and spatial variability of strong motion and the effect of soil conditions on earthquake amplification involves field study on amplification of ground acceleration in tall buildings collection of basic data to understand vulnerability of Delhi mega city to future earthquakes and generation of field data to provide precise R&D input for developing methods to reduce seismic risk to tall buildings. In collaboration with RITES, New Delhi a detailed geotechnical map of the region has been prepared which shows the sub soil profile of each site.

Sixteen Digital Strong Motion Accelerographs have been installed at selected sites in and around Delhi in a manner that all the areas of previous epicentres and different soil classification are covered. Data collection is in progress.

# TECHNOLOGY

## Beneficiation of phosphogypsum

Beneficiated phosphogypsum is an useful substitute for high purity natural gypsum for making different grades of gypsum plasters and plaster products and is eminently suitable for making low cost water-resistant cementitious binders for use in masonry mortars, plastering, building blocks/bricks, fibre reinforced (natural/synthetic) boards etc, thereby conserving cement. However utilization of phosphogypsum is easier after beneficiation.

CBRI has set up the first indigenous phosphogypsum beneficiation pilot plant with a capacity to beneficiate one tonne of waste phosphogypsum. The plant is complete with all necessary equipments and processing accessories to produce ready to use product.

### Polymer modified cementitious (PMC) tiles for buildings

CBRI as part of its R&D efforts to develop innovative building materials based on polymers has developed good quality PMC tiles using cement aggregate, polymers and some additives. These tiles exhibit improved quality and durability, besides having excellent wear resistance, low porosity and high mechanical strengths. They are cost effective and being fungal resistant are also environment friendly.

### Automation of Bekelman beam

Under a sponsored study of Ministry of Surface Transport, a μ based system has been developed by CRRI for using in conjunction with Bekelman beam to measure road surface deflections for overlay design. Automation of surface deflection made by Bekelman beam for pavement evaluation/overlay design leads to direct display of deflections and overlay thickness. Test results with the developed system are very promising.

### Interlocking concrete block pavement technique for special locations

CRRI has developed interlocking concrete block (ICB) pavement technique for special locations such as bus/container terminals, industrial roads, snow bound regions as well as for rehabilitation of old concrete surfacing. This technique has proved to be good alternative for difficult locations. Properly designed ICB has high dimensional accuracy, high compressive strength, better durability and high abrasion resistance. They are capable of providing a maintenance free surfacing for longer periods at troublesome locations.

## SERVICES

### Interactive computer software for analysis and design of ships and ship structures (CODES-I)

Hindustan Shipyard Limited (HSL), Visakhapatnam presently uses a SERC,M developed software (CODES) for the analysis and design of ships and ship structures. HSL expressed a need to upgrade the existing CODES system to include user-friendly features, graphics and pre- and post-processors. SERC,M accordingly developed CODES-I, an Housing & Construction upgraded version of the software on Unix platform using OSF/Motif graphical user interface (GUI) on X-window system for PC-486 machines, as well as workstations.

### Experimental and theoretical investigation of clamp rings

SERC,M took-up sponsored work for an industry in Chennai to provide inputs for the design of clamp rings for spring brake actuator assembly.

### Investigation of fire affected reinforced concrete framed building

SERC,M was approached for carrying out detailed assessment of the damage due to fire at the refrigeration plant of a company at Bangalore and to suggest necessary repair measures. Assessment of the condition of the concrete in the fire-affected concrete members was made using systematic ultrasonic scanning, rebound hammer tests and residual compressive strength measurement.

The results pointed towards substantial micro and macro-cracking of cover regions of the concrete members. Suitable repair measures were recommended for restoring the building for the normal activities.

## HUMAN RESOURCES DEVELOPMENT

### International seminar on natural road disaster reduction

CRRI organised an international seminar on national disaster reduction for roads on behalf of Permanent International Association of Road Congress (PIARC) G-2 Group at New Delhi in January, 1997 in the framework of International Decade for Natural Disaster Reduction supported by the United Nations (1990-1999).

The Seminar highlighted Natural Disaster activities in Asia such as earthquakes, landslides, floods, volcanoes and cyclones and other major areas related to evaluation and prediction of hazards, laws and regulations, preventive measures, disaster preparedness, emergency planning and management, repairing of infrastructure and post event measures.

### Indo-US workshop on ground improvement using geosynthetics

A three day workshop on `Ground Improvement Using Geosynthetics' was organised by CRRI in collaboration with University of New Orleans, Louisiana, USA under Indo-US collaborative programme in science and technology in March 1997. Nearly 150 experts from diverse fields i.e., highway engineering, soil engineering, scientists and manufacturers discussed the issue over four technical sessions.

This workshop provided a forum for dialogue between those looking for solutions to India's needs in this area with the most current technical advances in American technology. An exhibition on geosyntehtic materials was also organised in which manufacturers of Geosynthetics from India and abroad participated.

### Special training programmes in highway engineering and roads

CRRI conducted three special training programmes during the year. These were on:

- **Highway engineering :** training programme for in-service highway engineers, traffic & transportation engineers of the Govt., Public and Private sector organisations related to roads and road transportation were organised and about one hundred engineers were trained.

  These programmes were organised to acquaint the trainee officers with latest know-how for implementation in the field of Highway Bridge Engineering; Elastomeric Bearings for Bridge Design Engineers; Materials Testing and Quality Control Techniques of Highway Construction; Design, Construction, Quality Control and Maintenance of Cement Concrete Roads, Pavement Maintenance and Management System among others.

- **Roads & embankments on soft grounds :** a special programme was organised to impart training on construction of roads and road embankments on soft grounds for the training officers of RC & DC, Sri Lanka.

- **Development of roads with special emphasis on rural roads :** a tailor-made training programme was organised to meet the specific training needs of the Ministry of Surface Transport, State PWDs etc. and was attended by 21 trainee officers of the level of superintending and executive engineers.

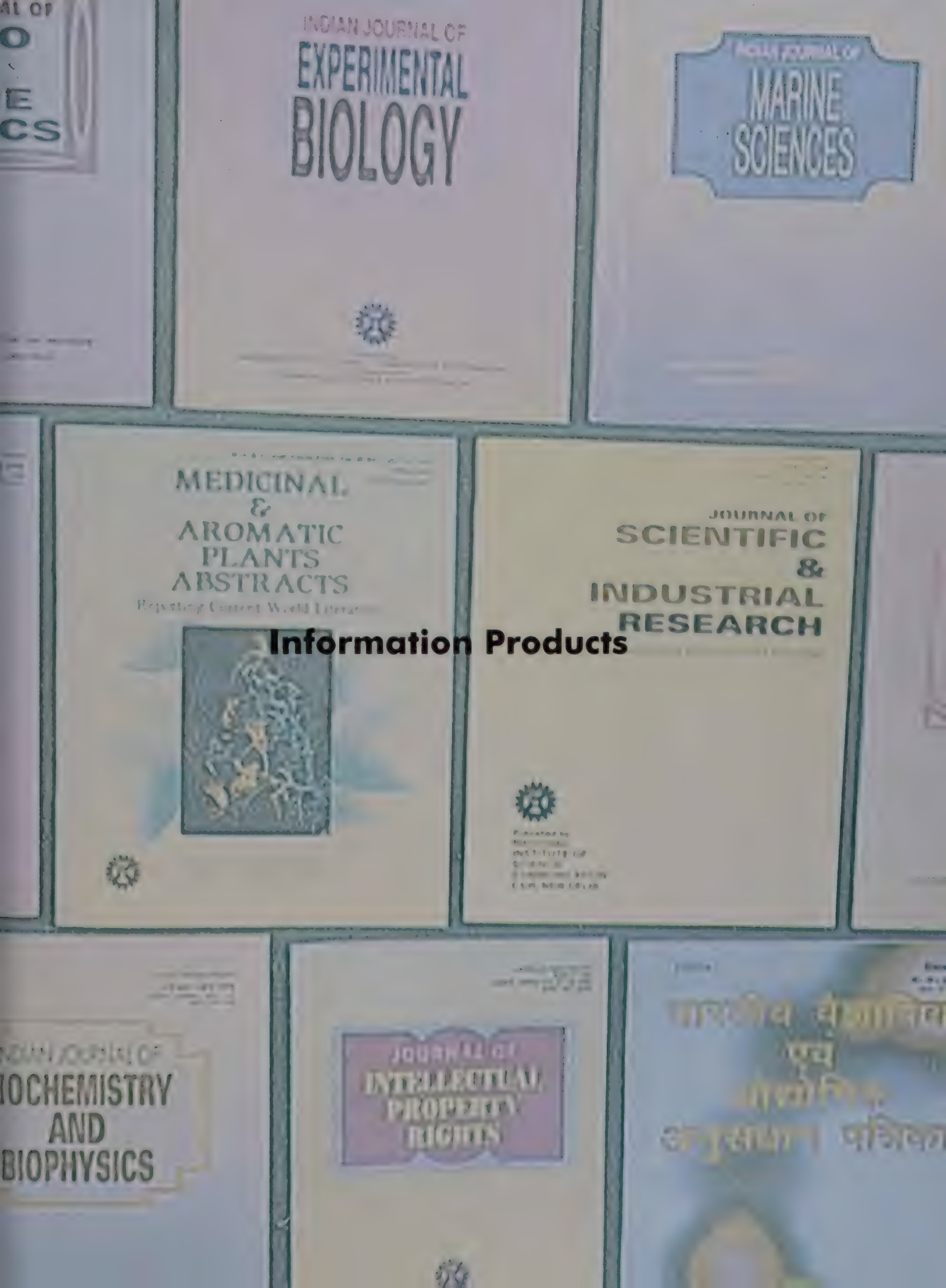
### Damage assessment and rehabilitation of distressed concrete structures

SERC,M organised an advanced training programme on the title theme in December 1996. More than forty trainee comprising senior design, construction and maintenance engineers from various state and central public works departments, R&D institutions and other organisations attended.

Topics covered included among others corrosion protection methods in reinforced concrete structure, importance of proper detailing of reinforced concrete, causes and remedial measures for distress in concrete structure subjected to dynamic loads, fatigue/ seismic damage, polymer concrete composite repair materials etc. Also guidelines for cost estimation and tender specifications for concrete repairs were presented.

### Vibration analysis & design of civil engineering structures

SERC,M organised an advanced course on the title subject in January 1997 for senior design engineers from various public and private sector organisations. Participants were exposed to various topics such as basics of vibration, dynamics of continuum structures, numerical techniques for analysis and design of dynamic problems, seismic analysis and design of structure, framed foundations for high speed machinery etc. among other important aspects of vibration analysis and design. Over 40 trainees took the course.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CSIR continued to provide valuable S&T information services and to promote S&T amongst children and lay public.

## SCIENCE

### Scientometrics and its applications

Scientometric technique for analysing scientific research output was used by NISTADS for examining certain issues relating to scientific developments in the country namely:

- Evaluation of the impact of Science and Engineering Research Council on research in Chemical Sciences. The work was sponsored by the DST.
- Study on the institutionalisation of Indian Physics research using publication's output from 1800 to 1950.
- Mapping of statewise scientific activity in terms of research papers output and patents output for 1984. The study shows that 50% of such national output came essentially from 13 cities.
- Examining composition of mathematics research in India from 1950-1990 to detect shifts in emphasis over time.

## TECHNOLOGY

### Popular science periodicals and books

Publication of popular science books under a new series — the `Q series', was launched by NISCOM with the publication of the book titled `What'. This is a lavishly illustrated book containing 100 mind boggling questions and answers thereto. The three regular popular science periodicals from NISCOM namely Science Reporter (English), Vigyan Pragati (Hindi) and Science-Ki-Duniya (Urdu) were brought out as per schedule.

### Collected works of eminent scientists on CD-ROM

INSDOC has undertaken a project to preserve the works for posterity of six eminent Indian scientists : Sir Jagdish Chandra Bose, Sir Shanti Swaroop Bhatnagar, Dr Homi Jahangir Bhabha, Dr Birbal Sahni, Dr J.N. Wadia and Dr Vikram Sarabhai through electronic imaging and recording on CD-ROM.

## SERVICES

### Publication of scholarly research journals

NISCOM publishes 13 internationally reputed scholarly journals covering the major disciplines of science. The research journals were brought out according to an integrated time schedule and covered 1651 papers (compared to 1363 during 1995-96) and the total number of pages printed were 8870 (compared to 7300 during 1995-96).

'Advance Abstracts' of the journals were also brought out regularly. A Chinese edition of the Indian Journal of Chemistry, Sections A&B was published with effect from June 1996 in collaboration with the Shanghai World Publishing Corporation.

## The Wealth of India (CD-ROM) Project-AHEAD

NISCOM brings out CDs under the project AHEAD (Asian Health, Environmental and Allied Databases) which is a consortium of 8 Asian countries contributing 9-10 databases, under the sponsorship of IDRC, Canada. The basic disk D2.1 on 'Wealth Asia' includes all the published volumes of The Wealth of India - Raw Materials series and was released in 1995. During 1996-97 information for updates of all the entries of raw materials series for a period of five years i.e., 1989-93 was generated and incorporated to produce D2.2 released in December, 1996.

## Electronic Library

The Pilot Electronic Library, developed at INSDOC, is a demonstration storehouse wherein 4925 foreign publications are acquired in electronic form including over 2000 full text journals, 2700 journals with abstracts, 230 IEE / IEEE conference proceedings, US patents (since 1990) etc. Based on this information resource, INSDOC offers the following information services:

- Standing order abstracts services (SOAS)
- Chemical abstracts keyword index service (CAKIS)
- Full text journal service (FTJS)
- Bibliographic search service (BSS)

## Photo-identity cards

INSDOC had undertaken in October 1994 a project for preparation of Multi-media Photo-Identity-Cards for electors of 12 assembly constituencies of the NCT of Delhi and nearly 10 lakh photo identity-cards were prepared. Impressed with the quality of INSDOC's work, the Chief Electoral Officer, Delhi in March 1996 assigned INSDOC the additional job of preparation of photo identity-cards for electors of 50 assembly constituencies out of a total of 70.

INSDOC has since developed an improved system for preperation and delivery of photo identity-cards on the same day. About 3 lakh photo identity cards have been prepared during 1996-97.

## Science and technology archival resources

As part of a continuing programme of collecting, maintaining and providing archival material on science, NISTADS brought out a collection of 60 reports of various committees constituted from time to time to review and examine the working of CSIR.

## Current Literature on Science of Science (CLOSS)

CLOSS registered a growing international readership ranging from scholars, scientists, technologists, policy makers, planners and industrialists. CLOSS, a monthly periodical reporting current international literature in the form of book reviews, summaries of grey literature and abstracts of research articles is published by NISTADS as part of the institute's activities on disseminating information in the field of science, technology and society.

## Value added patent information service (VAPIS)

A joint project of NISSAT, DSIR and NCL for providing value added patent information service was launched last year at NCL. The activities of the centre such as procuring suitable hardware, software databases mostly CD-ROM products in the area of chemical sciences patents information was started after the receipt of funds from NISSAT, DSIR. The centre has now procured the following CD-ROM products:

- US Patent Search Claims and Abstracts 1975+
- Patent Images US Chemicals 1990+
- European and PCT International Patent Application Bibliography
- European Patent Application (Images) 1990+Patent Bible (US)

To provide the CD-ROM based services 14 Drive CD-NET Tower was commissioned in the Library LAN.

## Standard time and frequency signals (STFS) service via INSAT

A coded standard time & frequency signal (STFS) broadcast system of high accuracy by NPL using the Indian domestic satellites INSAT-1B and 1D has been regularly broadcast since March, 1988. The usefulness of the STFS broadcast is that these signals can be received reliably anywhere in India and provide an online μ-sec level time synchronisation of 10-level frequency calibration.

The only other geostationary satellite based time dissemination service in the world is the American GEOS broadcast which gives lower accuracy levels. The STFS has made a significant impact with more than 30 users already availing this service.

The receiving set-up consists of a chicken-mesh antenna, 8 feet or larger in diameter, followed by a Low Noise converter and an FM receiver. NPL has designed and developed a totally automatic microprocessor controlled decoder, the know-how for which has been passed on to three licensees.

A collaborative project was undertaken between NPL and ER&DC, Trivandrum to develop a low cost STFS receiving system. The product was launched in 1996. The new design of the STFS receiver is very compact and attractive with several useful features including a 10 Mhz output phase locked to the received STFS to give an accurate frequency reference.

## International data exchange: radio and atmospheric sciences

NPL is operating the Regional Warning Centre (RWC), New Delhi as a part of an international network and is responsible for rapid exchange of solar and geophysical data within India and also with other centers located around the globe. RWC issues daily and special forecasts on solar and magnetic conditions based on the near real time data received from various observatories.

These forecasts are being used by a number of organisations including scientific and radio communication organizations. ISRO uses daily forecasts of solar and magnetic indices in orbital tracking and manoeuvring of low orbiting earth satellites.

An important development has been the availability of latest data from satellites at RWC such as information on solar wind, solar particle densities, interplanetary magnetic field, coronal holes etc. which can contribute greatly to the improvement of forecasts of geomagnetic activity.

To cater to the needs of a large scientific community in India and neighbouring countries, RWC has recently taken up a new responsibility of bringing out a monthly bulletin on solar and geophysical data.

## HUMAN RESOURCES DEVELOPMENT

### Training in AIS programme

INSDOC continued to conduct the prestigious Associateship in Information Science (AIS) programme started in 1964. INSDOC also organised 22 short term courses of which six courses were in computer applications to participants from library and information activities, three courses were on CDS/ISIS, one course was on bibliometrics three courses were on office automation and four courses on INTERNET.

### Training in science writing

NISCOM organised a five day training programme on `Writing a Scientific Paper' in November 1996. Twenty one participants from universities and CSIR labs participated.

## RECOGNITION & AWARDS

| | |
|---|---|
| NCERT National Award for Children Literature (1997) | Khalil, Shri Mohammad (NISCOM) |
| Children's Literary Award (1995-96) | Pathak, Shri TP (NISCOM) |
| Atma Ram Award for Excellence in Writing in the areas of S&T Literature and Equipment Development (1996) | Pathak, Shri TP (NISCOM) |

# Leather

State-of-the-art facility at CLRI for testing of eco-sensitive leather chemicals.

Improved chrome recovery/reuse system.

'Operation Green Star' for Tamil Nadu Tanneries: execution of MOU between AISHTMA and NEERI/CLRI

Training in cutting, assembly and stitching of leather goods/garments

The Leather Technology Mission (LTM) for the sustainable development of the Indian leather sector initiated by the CSIR in 1995 has made visible and tangible impact on the industry. Besides CLRI's efforts have been focused on development of processes and processing chemicals that are more eco-friendly than the present ones.

## SCIENCE

### Studies on the desamidation of Bovine collagen

CLRI has carried out studies of desamidation (CDN) on Type 1 bovine collagen which causes progressive hydrolysis of the amide groups of asparagine and glutamine side chains of collagen. Loss of amide brings about an increase in the number of free carboxyl groups in the collagen.

The fibril formation of the modified collagen showed slight variation and polyacrylamide gel electrophoretic analysis indicated largely by alpha components, indicating destruction of inter and intramolecular crosslinks. The swelling behaviour of the modified collagen is significantly higher compared to Type I bovine collagen.

## TECHNOLOGY

### Leather Technology Mission (LTM)

Under this pioneering Mission a total of 126 projects covering 15 States have been launched of which 58 were completed by January 1997. The progress on some of the activities is as follows:

- Carcass recovery centres were established at four locations viz. Kallupatti (Tamil Nadu), Kalyani (West Bengal), Seahore (MP), Tranaja (Gujarat) and thirteen centres are nearing the commissioning stage.
- Animal health care system benefits of improved animal health care systems have been demonstrated through a pilot study at Gudur (AP) where 30,000 goats/sheep were provided with pox vaccine and chemicals for deworming resulting in quality improvement in meat, hide and animal growth.
- Process control and modernisation : three tanneries in Uttar Pradesh and one tannery in Haryana have been modernized using add-on systems.
- HRD initiatives : an innovative pedagogic programme has been initiated for imparting education to tannery workers through vocational working using appropriate course modules designed in collaboration with IGNOU, New Delhi.

### Non-enzymatic and sulphide free dehairing process

CLRI has developed an alternative to the conventional sodium sulphide method of dehairing skins. The process is non-enzymatic and substitutes sodium sulphide with nickel carbonate. Goat skins were successfully dehaired by the new process and by conventional techniques made into crust leather.

The process is comparable with sulphide-lime system in terms of duration and efficacy of the dehaired skins. Unlike sodium sulphide unhairing, this method helps retain the natural colour and the crust leather is softer than the control leathers.

### Split coating technology

The technology of processing `splits' has been standardised by CLRI. It consists of two phase chrome tanning followed by heavy retanning with syntans/vegetable tannins, the process by which fibre solidity and inelasticity are enhanced without minimising the `softness' of splits. The result is a high grade upper leather with superior `nap'.

### Catalytic oxidation of dissolved organics in tannery effluents

Hydrogen sulphide liberated when the sulphide in tannery effluents stream react with the acids in the limeyard process stream in the tannery, is toxic to human and anaerobic bacteria. CLRI has developed a method of catalytic oxidation of tannery effluent organics using rice bran activated carbon catalyst.

The catalytic reactor consists of an integrated single system combining chemical and biological zones to perform the oxidation reactions using rice bran based activated carbon. Discharge levels of BOD at 30 mg/l and COD at 250 mg/l conform to pollution control standards. The process has been successfully tested in a commercial tannery having an effluent of 40,000 litres/day. A patent has been filed for the development.

### Improved chrome recovery/reuse system

CLRI has developed a semi-continuous chrome recovery/reuse system for a wool-on sheep skin processing plant of a private sector firm. The process provides an on-line chrome recovery approach with sodium carbonate as alkali precipitant of chromium, and polyetectrolytes for further facilitation of precipitation.

### CLEARTAN 'Al' & 'Cr'

A high molecular resinous product, CLEARTAN AL with ligating sites, most suited for irreversible binding Al(III) and Cr(III) as well as lowering the excitatio. energy (responsible for photo oxidation) of the organic molecule has been developed at CLRI, as also a new basic chromium sulphate salt (CLEARTAN CR) which avoids the formation of low affinity cyclic tetrapositive chromum (III) complex thereby promoting >85% absorption of tanning material.

### A novel bone implant - Maxibloc

An osteoinductive and bone filling material - `Maxibloc' has been developed by CLRI which contains hydroxyapatite and fibrillar collagen. The material was initially tested on tibial defects of dogs. Thereafter clinical trials were undertaken in the defective alveolar bones of human patients at Madras Dental College. Excellent ossification was observed in all the patients with no rejection or foreign body reaction. The ossification was complete within 4-6 weeks.

## SERVICES

### Productivity gains in footwear manufacture

An interactive software package has been developed by CLRI and C-MMACS for contour mapping of strength characterization for shoe upper leathers from goat and cow hides. This software package facilitates better `cutting value' of leather through identification of sites for cutting shoe-cut components based on their intrinsic lastability value.

## Operational Green Star- technology plan for tanning sector in Tamil Nadu

The scientific standing of CLRI was put to challenge in finding technological solutions for the problems of pollution from leather industry in Tamilnadu. Although (more than 740) tanneries in Tamil Nadu had set up pollution control devices, they could not fully comply with the norms specified by Tamil Nadu Pollution Control Board (TNPCB) as the end-of-the pipe treatment solutions could achieve only limited pollution mitigation. Thus the cathartic state of tanning sector in Tamilnadu in the aftermath of Supreme Court judgement in 1996, required immediate and long-lasting solutions.

A path-breaking and pioneering agreement was signed on 1st January 1997 between All India Skin and Hide Tanners and Merchants Association (AISHTMA) and CLRI/NEERI to provide such a solution. The umbrella agreement commits two CSIR laboratories NEERI and CLRI to advice, guide and help the tanners in evolving in-plant cost effective process control and enhancing performance efficiency of CETPs so as to achieve the TNPCB standards.

The solution was designed as a three-way plan: pollution control, treatment and continuous management. The plan is progressing as per schedule.

Phase-I of the project comprising site surveys, estimation of quantity and characteristics of wastewaters, bench scale treatability studies, evaluation of operation of CETPs and review of designs of CETPs under construction, delineation of measures for discernible improvement in the performance of existing CETPs, and redesign of most cost-effective and appropriate treatment options for CETPs under construction was completed by NEERI.

## National database on leather products

A landmark initiative of CLRI, Council of Leather Exports (CLE) Chennai, AISHTMA, Small Industries Development Bank of India (SIDBI) Leather Technology Mission and Tata Exports was a comprehensive 'Nationwide survey on leather products'. The survey encompassed 120 leather products manufactures/exporters and 1444 household units in the decentralised sector of footwear industry spread over 15 states.

## Centre for eco testing laboratory

A state-of-the-art facility for testing eco-sensitive chemical substances in leather processing has been commissioned at CLRI with generous funding support from the Ministry of Commerce, Government of India and the facilitation by the Council of Leather Exports (CLE) during the year 1996. This facility will enable proactive preparedness in meeting the challenges of restriction on chemical residues in leather in exports to some countries.

## Fashion forecasting for MODEUROP colours

India through CLRI has gained a niche status in forecasting of fashion colours through MODEUROP. Several Indian colours developed by CLRI have been included by MODEUROP Congress among the fashion shades for spring / summer 1997, autumn/winter 1997-98 and spring/summer 1998.

# HUMAN RESOURCES DEVELOPMENT

## Professional training in leather processing and product design

CLRI conducted number of academic and vocational training courses in leather technology and leather goods design. The specific courses conducted and beneficiaries were as follows:

### Academic Programmes

- B.Tech (Leather Tech) - 33 beneficiaries
- M.Tech (Leather Tech) - 2 beneficiaries
- M.Tech (Footwear Science & Engineering) - 11 beneficiaries
- Ph.D. - 10 beneficiaries

### Vocational courses

- Leather Processing - 51 beneficiaries
- Leather Goods (Garment Design & Technology) - 219 beneficiaries
- Footwear (Design & Technology) - 56 beneficiaries.
- Executive Training (Testing, Quality Control, Safety Audit) - 43 beneficiaries
- Miscellaneous (Enzyme Engin-eering, Eco testing) - 16 beneficiaries.

## RECOGNITION & AWARDS

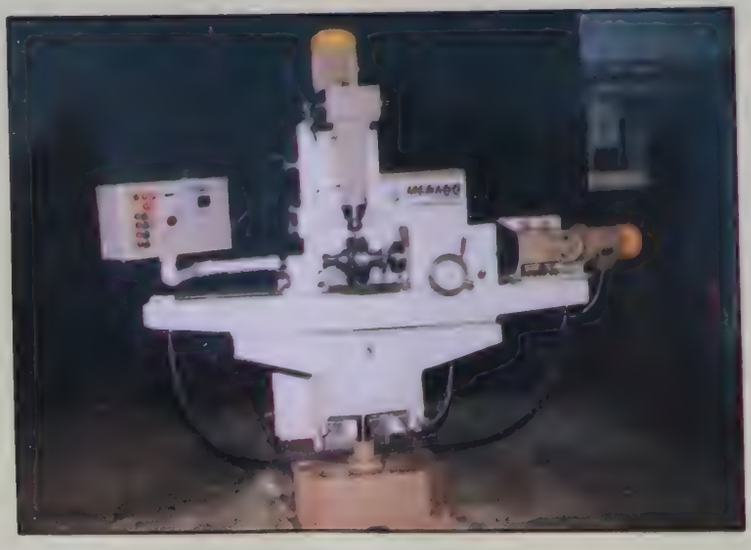
| | |
|---|---|
| Fellow of Indian National Science Academy | Chandrakumar, Dr N (CLRI) |
| S.S. Bhatnagar Prize in Chemical Sciences (1996) | Chandrakumar, Dr N (CLRI) |
| CSIR Young Scientists Award in Chemical Sciences (1996) | Jayakumar, Dr R (CLRI) |

# Machinery & Equipment

Stitch bonding machine

Powder X-ray diffractometer

C-brick machine



SPM for globoidal cam

Fluidised bed dryer

CSIR has been concentrating on developing machinery and equipment to enhance the productivity and efficiency of processing local raw materials and produce.

## TECHNOLOGY

### Ion beam microetching & milling equipment

NPL has developed an ion beam micromilling equipment, an important facility for preparation of specimens for microstructure analysis by transmission electron microscopy (TEM) and a high efficiency ion source based on a new dual oscillatory discharge concept for this equipment.

The ion beam system has been configured for achieving uniform, undiffused, intense ion beams of various gaseous species to achieve a fine, sharp anisotropic and selective microetching/milling of a variety of bulk materials for thickness of 100 $\mu$m or more for preparing their cross sections for structure analysis in TEM. It has the flexibility for iostropic rapid and polish etch at varied angles. It incorporates ion beam transmission through etched membrane, a new technique, to monitor, control and auto-terminate milling process at predetermined level. This feature makes the system attractive for compound semiconductors VLSI and electronic devices.

### Improved expeller for mustard oil extraction

Mustard oil in its pungent form is widely preferred in many parts of the country. Despite the advances made in expeller technology, the extraction of mustard oil, is still done almost exclusively by traditional means employing antiquated wooden ghanis employing inefficient extraction methods that leave high oil residue in the cake.

MERADO, Ludhiana has taken up design development of expellers of 1 TPD capacity as a component assignment under the Technology Mission on Oilseeds and Pulses. Design, development and fabrication has been completed and trial runs conducted. The new expellers give product quality on par with oil produced by traditional ghanis in terms of pungency, flavour and taste.

These expellers have the advantage of optimised yield on account of low residual oil in the cake, continuous processing, longer life of critical components and also hygenic output.

### Fluidsed bed dryer for oilseeds

Drying of agrocrops is an important post-harvest operation to ensure safe storage. At the instance of the Technology Mission on Oilseeds and Pulses, CMERI undertook the design and development of fluidised bed dryer for mustard, rapeseed, sunflower, groundnut etc.

An experimental pilot unit of 100 kg/hr. capacity was worked upon to generate design data for a semi-commercial unit of 2 tonnes/hr. capacity for drying mustard and rape seeds. Design/process parameters such as feed rate, moisture content of seeds, flow rates and temperatures of inflow hot air/exhaust air, bed height and temperature, pressure drop etc. have been optimised.

Additionally computational method for predicting drying behaviour of the seeds has also been established. A systematic thermal design methodology involving drying requirements,

heat and mass exchange has been evolved. It is proposed to extend this methodology to cover other oilseeds and thereafter to the value added agrocrops such as tea, coffee, spices etc.

### Stitch bonding machine

CMERI has designed and developed a stitch bonding machine for manufacture of geotextiles which are presently in great demand for stabilisation of erosion habitually occurring in the hill slopes and other vulnerable surfaces and also for the presently popular straw mattresses.

Developed under sponsorship of private industry the key design feature of the machine is the stitching system to stabilise in place the loose composition and matrix of the filling material, mainly agrowastes such as wheat/paddy straw. The design know-how has been licensed to the sponsor.

### High speed precision indexing unit using globoidal cam

Indexing units find widespread application in diverse industries. CMERI developed a high-speed precision indexing unit using globoidal cam with a view to develop appropriate manufacturing methods for critical components with complicated geometry. The machine makes use of a versatile and commonly used indexer which provides excellent performance for any number of steps, any motion and virtually any speed or load.

The special design of the machine minimises the effect of roller reversal and also allows a longer indexer life. Efforts are on to transfer the design know-how for commercialisation.

### C-brick machine

A user friendly brick shaping machine based on the principle of vibro compaction is yet another R&D contribution of CSIR from CBRI for gainful utilisation of flyash the inevitable atmospheric pollutant from thermal power plants. It provides a cost effective technology for producing bricks from flaysh using either cement or lime as binder and is ideal for self employment particularly in the areas around flyash dumps.

A machine with capacity to produce 2000-3000 bricks per day requires an initial investment of about Rs.2 lakh. The first machine designed and fabricated wholly at the institute was released to industry on the occasion of the Golden Jubilee of India's independence which coincides with the Golden Jubilee of CBRI.

### Powder x-ray diffractometer

A powder x-ray diffractometer has been designed, developed and fabricated at NPL under a project sponsored by DST. It has been thoroughly tested by recording diffraction patterns of a number of materials starting with silicon powder. The diffraction patterns have been on par with the standard data available from the internationally accepted data supplied by Joint Committee for Power Diffraction Standards (JCPDS). The data, such as values of interplanar spacings for different reflections obtained from diffractograms of the indigenous diffractometer was found to be in good agreement with that reported in JCPDS files.

### Arch setting device

CMRI has developed a steel arch setting device which can set steel arches in underground mines very quickly and easily. The conventional process of setting steel arches is cumbersome,

time consuming and requires deployment of a crew of about 12 to 14 persons to set a single arch. The newly developed device makes it possible to install 12 to 14 arches in a day by a crew of just 2 to 3 persons.

This mechanical process eliminates the use of wooden logs or additional support generally required and provides a setting load of 5 to 6 tonnes. The device developed is easy to operate and costs of maintenance and repairing would be negligible.

## SERVICES

### Rock testing facility

CMRI has developed indigenous low temperature rock testing facilities in collaboration with IIT, Kharagpur under an Indo-US collaborative programme. The facilities enable testing of any type of rock, metal, concrete block composite or other solid materials from room temperature to -7°C under the application of compressive or tensile forces.

### At site calibration facilities

At site calibration facilities have been designed and generated by NPL to meet the customers demand for validating the calibration status of heavy and non-portable measuring/machining facilities.

Due care is being taken in designing the measurement setup at the site of the customer in order to achieve the necessary tractability and measurement uncertainty to meet the calibration requirement of the instrument under consideration. Main transportable standard equipment/ standards used for at site calibration being:

- HP laser interferometer (linear) with the range/resolution of 30m/0.01 m with situations where HP interferometer is impracticable
- Length bars with the range 600 mm/0.5 m with length measuring machine where the ambient conditions do not permit the use of HP interferometer.
- Ball Plate (photo-attached) with the range 5232 x 523 mm/1.5 m with co-ordinate measuring machine.
- Step gauge with the range 1200 mm/0.5 m co-ordinate measuring machines.
- Autocollimator with the range 10 minutes/0.2 sec with the angular straightness and flatness calibrations.

Several public and private sector organizations are availing of the facility at their premises

### Computerised milling machine

NPL houses a high precision `Deckel FP4A' 3 1/2 Axes CNC milling machine capable of machining complex 3D surfaces, profiles and cams and is best suited for prototyping, precision machining and machining of die cavities, cores, EMD elctroders, micro wave components etc.

The application of the imported software for CAD-CAM surface and solid modelling has made the facility very versatile, adding another dimension to its machining capabilities. The facility has now been further strengthened with the addition of Gildemeister CT-200 CNC lathe capable of producing precision turned components.

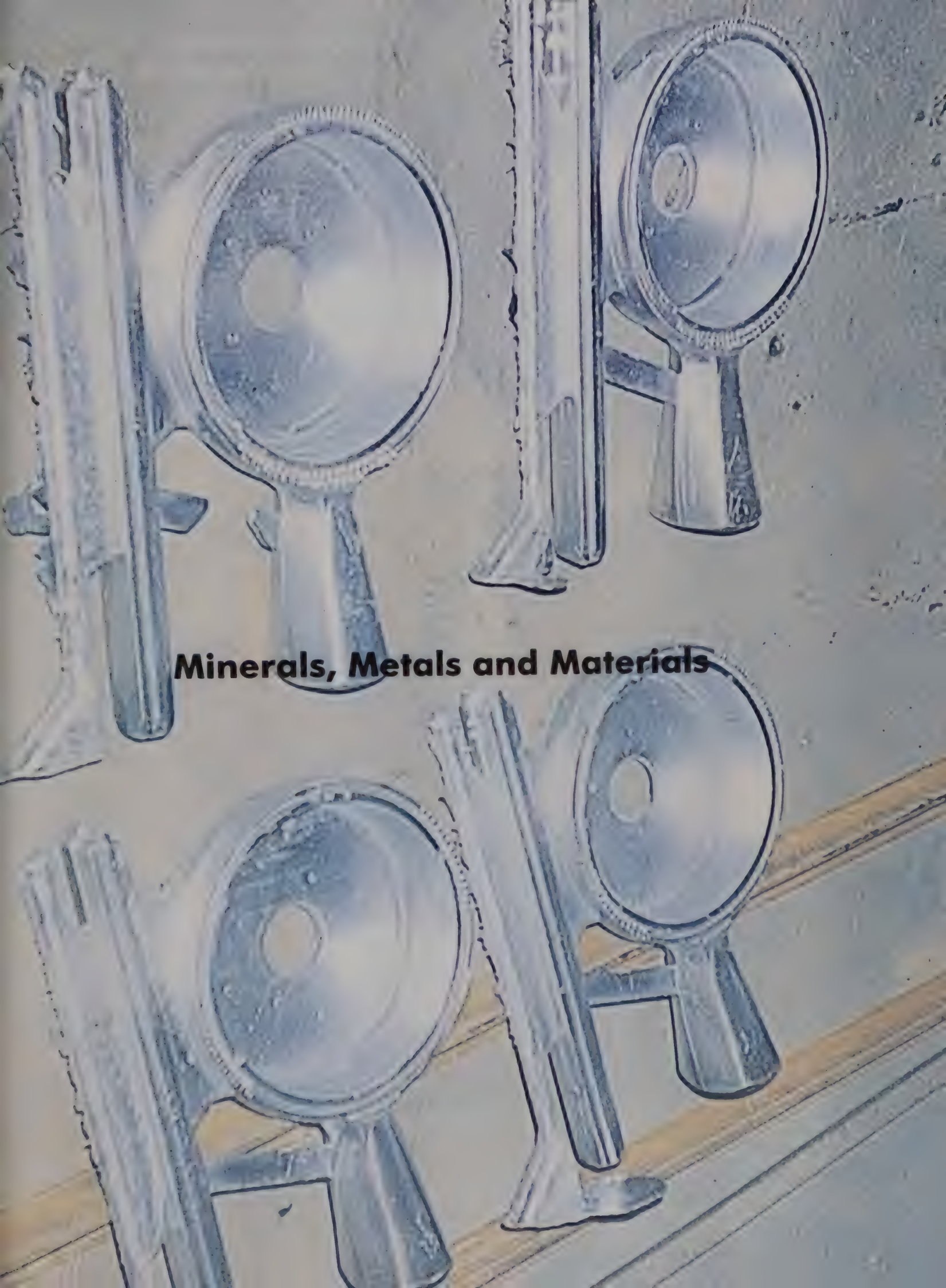
## HUMAN RESOURCES DEVELOPMENT

### Advance professional training centre

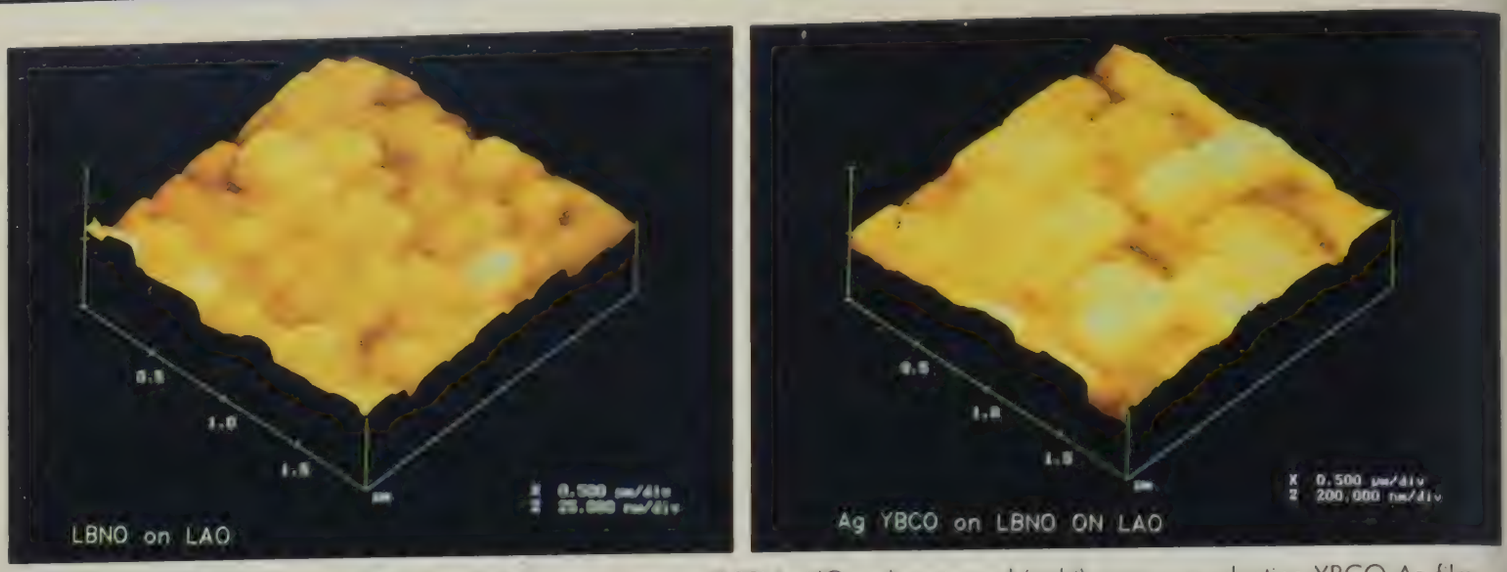
North Eastern region of India has long been facing lack of skilled manpower. Numaligarh Refinery Ltd. and RRL, Jorhat have jointly set up an `Advance Professional Skill Training Centre' in RRL, Jorhat for imparting training to ITI passed certificate holders in welding and advanced fitting trade. During the year 32 welders and 34 fitters were trained.

### Refresher course on non-destructive testing

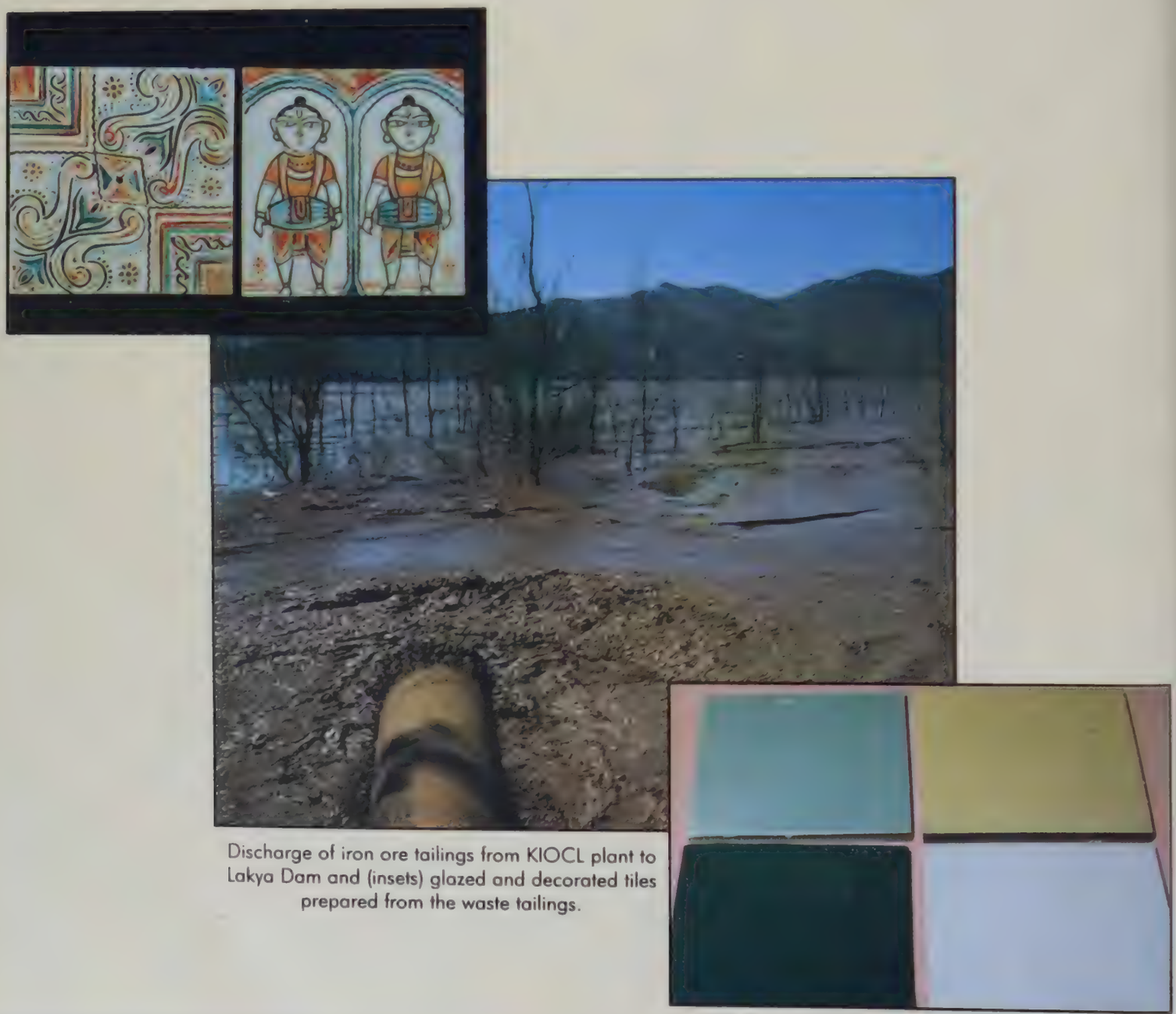
CMERI organised a refresher course on non-destructive testing for practising engineers utilising the institutes expertise base. A total of 22 external participants undertook this course. Also a short term training programme of engineering dimensional metrology was organised in which 11 candidates participated.



# Minerals, Metals and Materials




AFM images of (left) an epitaxial $Ba_2 LaNbO_6$ film grown on a (100) $LaAlO_3$ substrate and (right) a superconducting YBCO-Ag film grown on an epitaxial $Ba_2 LaNbO_6$ film.



Discharge of iron ore tailings from KIOCL plant to Lakya Dam and (insets) glazed and decorated tiles prepared from the waste tailings.

CSIR laboratories have been contributing diverse new materials ranging from substrates for superconductors to ceramic matrix composites to high performance materials for mining industry, besides retrofit designs for coke based foundries and other industries.

## SCIENCE

### Creep behaviour of engineering materials

A simple model based approach has been developed by NML to predict the effect of specimen geometry on the creep behaviour of a range of engineering materials. The model uses a set of coupled differential equations relating the evolution of creep strain and loss of section size to environmental interaction. The formulation is based on the assumption that the oxide layer that forms has poor ductility and cannot withstand any plastic strain and therefore it has no load bearing capacity. Material constants required to describe the process can be estimated from an analysis of experimental creep strain-time plots of specimens having varying section size over a range of stress/temperature. Available creep data on steel and super alloys have been used for validation of the model.

### High performance materials for mining equipment

Short life spans of equipment/implements due to higher wear rate is a matter of serious concern for the mining industry. One of the effective methods to improve the life of component is through the design and development of high performance material. Aluminium metal matrix composites and Z-A alloys are found to be light weight, improved wear resistant with other related properties. Under joint sponsorship of Ministry of Mines, DST and CSIR, RRL, Bho has taken up a project for the development of cost and energy effective high performance materials for mining equipments. Components being studied are:

- Vortex finder, refrax apex insert for cyclones and impeller and inlet for Sala pumps to be made of Al-alloy composites,
- Bearings for shovel and other mining mercenaries to be made of SLIZ alloys,
- Improved materials for grinding balls for ore grinding.

### A new perovskite substrate for YBCO superconductor

RRL, Tvm has developed a new perovskite substrate material, $Ba_2$ $LaNb0_6$ (BLNO), for YBCO superconductor. Since the discovery of $YBa_2Cu3O_7$- (YBCO) super-conductor, there has been wide spread interest in producing this material as thin films with high critical current density for various device applications, in the preparation of which, substrates play a vital role. However the high chemical reactivity of YBCO with most of the commonly available substrate materials at the processing temperature imposes severe restrictions on availability of substrate for YBCO superconductor. Satisfying most of the substrate requirements BLNO is found to be chemically non-reactive with YBCO even under severe heat treatment (<950°C) and has low dielectric constant and loss factor values making it suitable for microwave applications. The superconducting YBCO film grown on an epitaxial film of BLNO showed excellent super-conducing properties and gave a current density of ($6x10^8$ A/$cm^2$) at 77K.

### Study of the implication of chaos theory on suspension rheology

The current methods of analysing the theology of dilute suspensions do not allow for the existence of chaos in the material parameters. RRL-Tvm is the first school to study the implications of chaos theory on the analysis of suspension rheology, through a technique based on a brute force integration of the relevant evolution equations that allow for the

existence of chaotic rheological parameters. The technique developed has been used to demonstrate for the first time that rheological parameters can evolve chaotically. A new technique for control of chaos has also been developed. The development of theories for suspension rheology which allow for the existence of chaos could revolutionise the current approach to analysing and designing equipment for processing suspensions which occurs across a wide variety of industries. This could lead to the development of suspensions whose theological parameters could be varied by adjusting a control parameter using control of chaos techniques. The theories which have been developed at RRL-Tvm. could also provide new insights into the analysis of many experimental data where chaotic fluctuations may not have been recognised as such.

### Kinetics of the reduction leaching of manganese nodules

Rate expressions under various limiting conditions have been derived using the principle of mixed potential (em) and mixed current (im) for leaching of ground manganese nodules for extraction of metal values at RRL Bhu. The validity of these expressions has been tested by using electrochemical polarisation data determination from pelletized electrodes of $MnO_2$ and $FeS_2$, and also from actual leaching data in acid medium. These results are of practical significance to industrial leaching practices to check dissolution of Mn and Co.

## TECHNOLOGY

### Cement free castables

The high alumina, cement-free, dense, self-flowing castable developed by CGCRI is characterised by higher modulus of rupture, better creep resistance, higher strength at elevated temperatures and better thermal shock resistance compared to the low-cement castables containing approximately 5% alumina. Hence, these materials could be used as refractories for the present day converters and continuous casting units of steel melting shops which are operated at much higher temperatures. The CGCRI materials have two additional advantages namely avoiding the addition of any CaO bearing material and dispensing with vibrations during casting. A patent has been filed in India and several entrepreneurs have envinced interest in obtaining the technology.

### VSK process improvement

The VSK technology developed by RRL, Jt for production of cement is widely commercialised. The laboratory is, now incorporating modifications to improve the technology in terms of fuel efficiency, yield, use of alternative fuel (such as agro wastes) pollution control, improved air distribution system within klin and air lock chinker discharging system.

### Ceramic matrix composites by Rapid Heating Self Propagating High Temperature Synthesis (RH-SHS)

A RH-SHS technique was developed by NML for synthesis of ceramic matrix composites. A heating rate of about 400°C/min. was employed to synthesise the composite thereby reducing the segregation in solid-liquid reaction system and facilitating the densification simultaneously. The RH-SHS scheme thus opens up the possibility to synthesise near net shape composites.

### Green coke based high density isotropic graphite

High density high strength isotropic graphite is a recent addition to existing family of carbon products. It refers to a speciality graphite which possesses a bulk density of more than 1.9 g/

$cm^3$, bending strength of more than 600 $kg/cm^2$, degree of anisotropy of 0.9-1.0, along with a homogeneous and fine micro-structure, and finds potential applications as EDM electrodes, electrodes, electrical brushes and contacts, heaters, crucibles, jigs, hot pressing dies, nuclear graphite, rocket nozzles and moulds for continuous casting of metals and alloys etc. Its domestic demand is met through imports valued around Rs. 10 crore per annum. Extensive work has been done at NPL under sponsorship from industry to develop this graphite from self sintering carbonaceous powder obtained from coal tar pitch by suitable treatment. Technology transfer is being negotiated.

### Decarborisation of pig iron

RRL-Bhu has standardised parameters for decarborisation of pig iron to make it directly usable for spur pipe manufacture. Experiments carried out in a tamman furnace (35 KW) using blue dust/mill scale at a temperature around 1450°C to reduce the carbon content in pig iron by 0.5%. The process offers better economics compared to spun pipe grade pig iron with 4% carbon which prevents its direct use, adding to cost.

### Development of ceramic tiles from iron ore tailings

Under a sponsored programme from an industry generating huge amount of iron ore tailings, NML has developed technology to produce floor and wall tiles both glazed and unglazed from these iron ore tailings. NML has also provided the necessary techno-economic data to the sponsor for setting up a commercial plant.

## SERVICES

### Indian reference materials

Two new certified reference materials of multi-elements in water i.e. copper, iron, zinc in a nominal concentration and nitrate also in a nominal concentration had been prepared at NPL. These solutions were sent to sixteen laboratories participating in the inter-laboratory programme for preparation of certified reference material (Bharatiya Nirdeshak Dravyas). The experimental data received from the laboratories are under compilation and in the process of assignment of true values. NPL participated in and international programme of water proficiency testing organized by National Association of Testing Authorities (NATA) Australia. In this programme twelve samples were analysed for total forty five entities, and values assigned to forty four entities were found in the acceptable range.

### Pre-concentration of uranium ore by froth flotation

On request from industry bench scale froth flotation studies were carried out by NML on uranium ore sample from Domiasiat, Meghalaya. Flotation experiments were carried out under varying conditions of various process parameters using potassium amyl xanthate and cupferron as the collector for uranium bearing minerals. Considering the high cost of cupferron diethyl hexyl phosphoric acid, alamine 336 and tri-butyl phosphate were tried as alternative reagents in combination with light diesel oil and xanthate. These also resulted in reasonably high recovery of uranium values in the flotation pre-concentrate.

### Synthesis of Mn-Zn ferrite from beneficiated iron ore fines from Kudremukh

Under a sponsored project NML undertook to develop process flowsheet along with generation of sufficient quality of concentrates by physical as well as chemical beneficiation routes for

synthesis of Mn-Zn and Ni-Zn ferrites using secondary magnetic concentrate (SMC) and mechanical flotation feed (MFF) from the process streams of client's plant. Physical beneficiation studies were carried out laying emphasis on flotation of silica with the use of improved reagent followed by chemical beneficiation studies. Mn-Zn and Ni-Zn ferrites were thereafter synthesised from the super-concentrates of MFF and SMC and prototype samples of E and RM cores were made and were found to conform to the required specifications.

### Lime refractories

CGCRI has initiated R&D for development of high density, hydration resistant 'lime sinters' and 'lime refractories' for cement and iron & steel industries with joint sponsorship of industry and DST. Preliminary investigations using relatively pure grade lime stone as starting materials has led to a high density, hydration resistant 'lime sinter' product with a bulk density of 3.14 $g/cm^{33}$ and grain porosity below 1% as against maximum 5% stipulated by industry sponsor. The hydration resistance test of such lime sinters at 50°C and 95% relative humidity for 3 hours showed only 2-3% dust below 35 mesh. This is well below the specified limit of 5% required by industry.

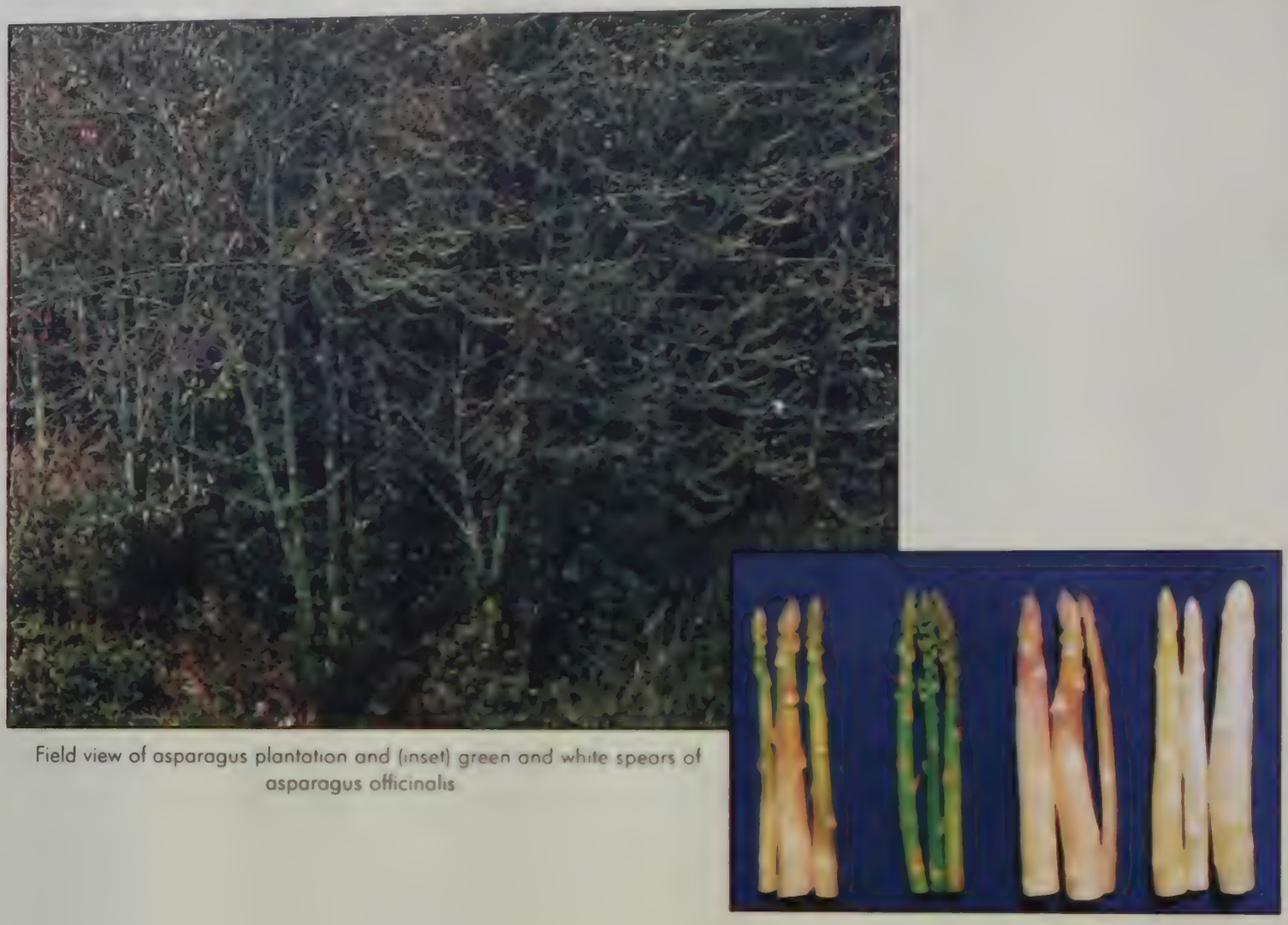
## HUMAN RESOURCES DEVELOPMENT

NML has organised six workshops and three seminars on diverse subjects ranging from computer applications in materials and metallurgical process to component integrity evaluation and life assessment. More than 800 engineers, scientists, technical and managerial staff were sponsored by the industries and academic institutes. NML has also published several priced technical publications, which are available from the laboratory.

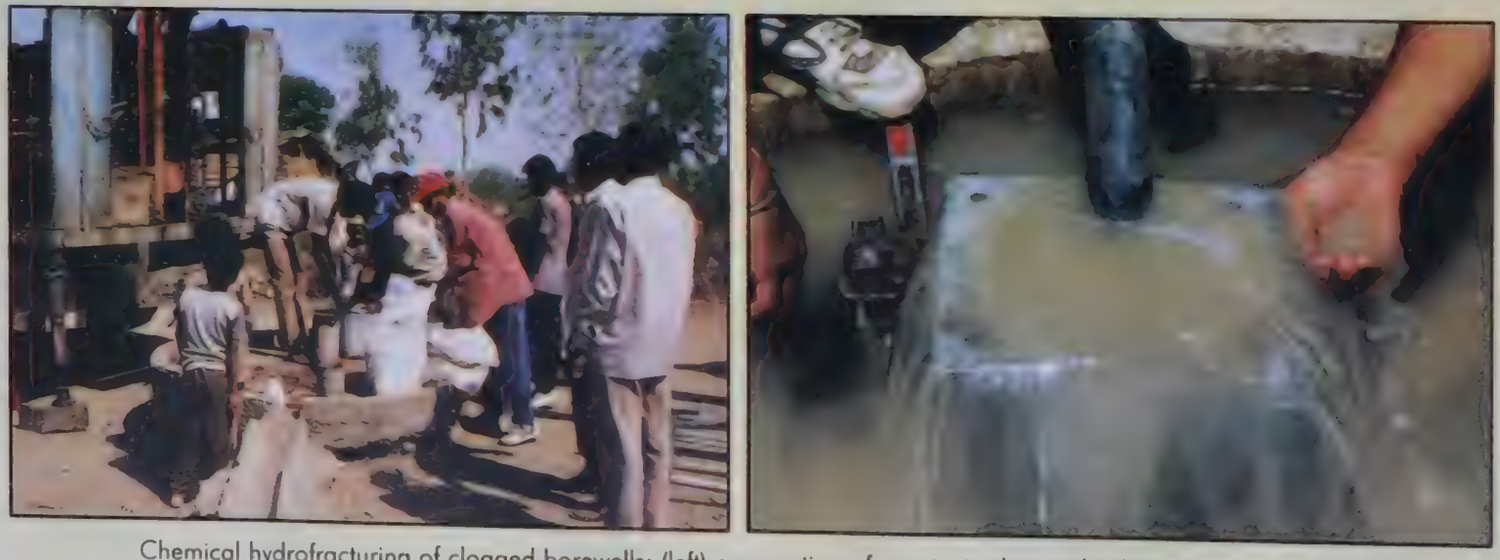
## RECOGNITION & AWARDS

| | |
|---|---|
| Material Research Society of India (MRSI) Medal (1997) | Banerjee, Dr G (CGCRI) |
| National Mineral Award | Barnwal, Dr JP & Govindarajan, Dr B (RRL, Bho) |
| Indian Science Association Congress (ISCA) Young Scientist Award (1996-97) | Patra, Dr A (CGCRI) |
| INSA Prize for Material Science (1997) | Ramachandra Rao, Prof P (NML) |

S & T for Societal Development



Field view of asparagus plantation and (inset) green and white spears of asparagus officinalis



Chemical hydrofracturing of clogged borewells: (left) preparation of non-toxic chemical solution for declogging and (right) removal of clogging material by backwashing.

CSIR recognises and acknowledges its responsibility to contribute S&T inputs for societal development. Thus nearly 50% of its laboratories contribute direct or indirect S&T inputs for this sector. The objectives have been to enhance the level of productivity and value addition and to create newer opportunity for self employment.

## SCIENCE

### Socio-cultural and historical perspectives of S&T

Research at NISTADS on historical background to the debates on science & environment in colonial India has revealed the prevalence of a dual relationship of the discourse with nature. While at one level it advocated domination of both nature and indigenous knowledge systems (practice of resource utilization) it also encouraged an intellectual discourse with self-sustaining natural transformations.

The project redefines the intellectual resources of the emerging community of natural philosophers on the peripher (India). Major information will be drawn from empirical and textual data, including narratives, diaries, reports on scientific forestry projects, meteorological observations, and personal notes emerging out of the expanding network of working naturalists.

A computerised database of The Indian Forester 1875-1950 is prepared using sources relating to environmentalism. NISTADS also made studies on exchange of ideas between pioneers of the twentieth century scientific revolutions and Indian philosophy which is collected in an unpublished monograph (with a preface by Ilya Prigogine).

Research on the emergence and growth of scientific community in India during 1991-92 led to an extended exploration in a comparative mode to the developing countries in Asia, Africa and Latin America. A volume on 'Scientific Communities in the Developing World' is published by SAGE Publication, New Delhi.

## TECHNOLOGY

### Improved variety of Asparagus

Asparagus, a highly nutritive vegetable known for its food delicacy in the west, is a perennial crop. RRL, Jm has developed an improved variety of high-yielding asparagus (code named SL-831) and introduced the plant in the northern parts of India.

The agrotechnology for its cultivation has been standardized and disseminated to about 200 growers through demonstrations under various public awareness and rural development programmes.

### Technology for rural wool craft

In rural wool craft the main item of production is the blanket. The production process however is primitive with most of the operations done manually. NISTADS developed an upgraded technology package consisting of a manually operated spinning device, small

work efficient loom and carding machine. The beneficiaries are 80 families engaged in rural wool craft in Bankura, West Bengal.

### Location of irrigation wells in Karnataka state

Based on the recommendations of NGRI over 200 wells were drilled in the arid regions of the state. The water yield from 121 wells was more than 1000 gph while from the the remaining it was less than 1000 gph. Some wells in the Tumkur district yielded between 5000 and 7000 gph, which is very high for geologically difficult terrains as Karnataka.

### Characterisation of building components

RRL, Bho undertook analysis of red mud fibre polymer door shutters and red mud fibre composite corrugated roofing sheets using 'finite element analysis of structures' (FEAST) and 'numerically integrated structural analysis' (NISA) software.

The design procedure through these packages have improved the reliability of the components. Further, the design has optimized the structure and led to weight reduction.

### Multi-sector rural network system of group enterprises

NISTADS developed a new approach built upon the inderdependent nature of economic activities involving local resources, skills and technologies in rural areas to provide for economies of scale and scope. This approach is pilot tested for establishing group enterprise capable of utilizing local resources and commercial financial channels to increase productivity and self-sustenance.

Feasibility reports were prepared at thirteen locations involving sectors of milk processing, wasteland recovery, plant based health system, food processing and rural construction, jointly with NGOs supported by the National Science and Technology Entrepreneurship Development Board (NSTEDB) of the DST. Each report constitutes a bankable project.

### High-tech protected environment nursery

An unconventional novel technique for raising and sustaining low cost nursery of difficult-to-root plant/tree species developed by NBRI depends totally on tailoring environmental conditions while dispensing with growth harmones. The technique can be successfully adopted for clonal and micropropgation of plant materials.

It has been demonstrated to twenty beneficiaries of a world bank activity in UP who have installed nurseries at their sites. Also nearly 400 other individuals have been trained and quality planting material provided to several farmers and forest department officials for long term gains.

## SERVICES

### Evaluation of drinking water in Kangra district

Under the auspices of Rajiv Gandhi Safe Drinking Water Mission, rural drinking water sources were monitored by ITRC for pathogens and pollutants to reduce water borne risks. A total of

111 samples of drinking water from springs, streams, rivers water supply schemes and hand pumps in Kangra district were taken up and analysed for microbiological and physiochemical contaminants and pesticides.

Sources of fecal pathogens, toxic metals, fluoride and pesticides have been identified and measures to control these recommended.

### Rejuvenation of clogged hand pumps

Under the sponsorship of Rajiv Gandhi National Drinking Water Mission, a process for rejuvenation of clogged hand pumps has been developed by RRL, Bho. The clogged wells are treated with a non-toxic chemical composition and hydro-fractured under high pressure and high velocity water.

Using chemical-hydrofracturing process, twelve clogged hand pumps in dozen villages around Bhopal city have been successfully rejuvenated. The success rate of chemical hydrofracturing process has been found to be about 90% with substantially high water yield from the rejuvenated wells.

## HUMAN RESOURCES DEVELOPMENT

### Training of rural/tribal artisans

RRL, Bho organised two important training programmes; these are:

- Training of trainers amongst tribal women in preparation of herbal formulations and handicrafts based on sisal fibres. Training was also carried out in backward areas of Chhindwara district.
- Training programmes on bell metal technology for tribal artisans involved in the trade from MP and Bihar.

### Rural development activity

RRL, Jt has helped establish commercial cultivation of aromatic plants and edible mushroom in the SC/ST dominated areas of NE region near Bhutan border, through intensive training. As a result 350 hectares were brought under citronella cultivation and a 500 kg/batch citronella distillation plant was set up while 50 families in the Jorhat and adjoining districts were assisted in taking up cultivation of edible mushroom.

### Training of IAS officers

The second training programme for IAS officers on 'Science and Technology in Development' sponsored by Department of Personnel and Training, Government of India was organised by NISTADS, The programme informed the participants of the role of science and technology in development and the S&T capabilities in the country.

It also provided a forum to IAS officers for discussions with experts and practitioners in S&T management. It was attended by 14 participants from nine states.

## Training of students in science and society

Short and long term training to 30 students from various academic institutions was imparted by NISTADS through project assignments.

## Orientation programme for managers of S&T (OPMOST-1)

The one week programme OPMOST-1 for Managers of Science and Technology (OPMOST-1) was organised by NISTADS in New Delhi. The participants deliberated upon issues relating to liberalisation/ globalisation, the role of S&T administration in the New Economic Environment; the changing role of government and industry; through lectures and interactive modes.

Officers from CSIR, DRDO, DST, ICAR, ICMR, BARC, ISRO, DAE, and from the Ministries of Steel and Non-conventional Energy Sources participated.

# Central Management Activities

CSIR Directors' Conference: Vice President of CSIR Prof. YK Alagh, MOS (S&T) Govt. of India, being received by Dr. RA Mashelkar DG, CSIR for the Conference held in December, 1996 and (below) Sports event-the Vice President's XI ready to bat in the cricket match vs DG's XI

Shri SM Datta delivering the Foundation Day Lecture on
'The Emerging Role of Technology'

CSIR is a multilocational and multidisciplinary organisation comprising 40 laboratories and 80 field stations, manned by a staff around 23,000 and with another 2500 S&T personnel in a floating mode. It functions within the confines of a significantly government funded organisation. The affairs and activities of CSIR are managed by the Director General, as the Chief Executive Officer of CSIR under the guidance and directions of the Governing Body, (GB) and S&T advice and assistance of the Advisory Board (AB) and the five Technical Advisory Boards (TABs) according to the policy directions outlined by the Society which has the Honourable Prime Minister of India as the President (organisational structure given at page i). Brief details of the activities of the over arching decision making bodies are given hereunder.

## CSIR Society

Hon'ble Prime Minister Shri H.D. Deve Gowda chaired the Society meeting held on 12th August, 1996. Among others who participated were Shri P. Chidambaram, Finance Minister, Prof. Y K Alagh, Minister of State for S&T & VP, CSIR and Prof. C.N.R. Rao, Chairman, AB. The Society called upon CSIR to continue its efforts to create an awareness about the issues involved in intellectual property under TRIPS and WTO and Indian capabilities to meet the challenge. The Society stressed that CSIR should focus its attention on developing technologies that were not available to Indian industry and affordable technologies for wide-scale application. The Society also urged upon CSIR to scout around for extra budgetary resources to enhance its financial inputs.

## Governing Body (GB)

The GB met twice during the year on 26th April, 1996 and 28th October, 1996. The GB deliberate on several crucial subjects, its decisions/directions on some of issues were :

- availing of a soft loan-assistance from ICICI under the World Bank supported Industrial Technology Development Project for CSIR HQ and three laboratories;
- adoption of new guidelines for overseas visits of CSIR personnel and visits of foreign scientists in CSIR;
- renaming of CSIR, Complex at Palampur as Institute of Himalayan Bioresource Technology (IHBT) and the Publications and Information Directorate at New Delhi as National Institute of Science Communication (NISCOM);
- providing financial support to Group IV scientists for membership of professional bodies; and
- renewal of scheme for engagement of consultants for Business Development.

The decisions of GB have been implemented.

## Advisory Board (AB)

The 14th meeting of the AB was held on 10th January, 1997. The AB interalia recommended that:

- a scheme be devised for early recognition of excellence in the CSIR;
- a system of `joint appointments' wherein a person could work in university/other R&D centres and at the same time provide R&D inputs and work in CSIR;
- CSIR focus its R&D on niche science knowledge based industry sectors;
- a review of the performance of select CSIR laboratories (NPL, CBRI, CEERI, CMERI, CSIO & IICB) be undertaken with a view to enable them to deliver outputs commensurate to their real potential; and
- the organisational structure of CSIR be modified to derive the optimal benefit of external advice and professional inputs.

The recommendations are being processed.

## Directors' Conference

The Director's Conference is an annual forum for Directors to meet and discuss issues/ problems of common generic interest. A three day Conference of CSIR Directors was organised in December, 1996. The Conference was held for two days at New Delhi and one day at IMTECH, Chandigarh. The issues discussed were: (a) Human Resources Management, (b) Roles, Functions, Powers & Accountability of TABs, MC, RC and Directors, (c) Availability and Shortfalls of Financial Resources, (d)Managerial Powers & Personnel, (e) Internal Customer Communication & Satisfaction Assessment-results of survey, and (f) Networking for Corporate Synergy. Some of the salient decisions arrived at were:

- A group to be formed for evolving New Career Advancement & Recruitment scheme.
- Organisational set-up to be modified as:

TAB: to be replaced by Task Forces;
RCs: to be replaced by RACs with no functional activities/ responsibilities;
MCs: to be replaced by Board of Directors (BOD) and their constitution changed; and
Directors: role to be incorporated in Memorandum and Rules.

- Joint Consultative Mechanism to be evolved.
- Networking of CSIR to be extended to all forty laboratories and not just 15 laboratories as thought of now. Financial resources to be complimented with internal funds if necessary.
- Customer satisfaction system to be established for not only external projects but also for 'Missions'.

An innovation in the Director's Conference was a Sports Meet of Directors at IMTECH.

## CSIR Foundation Day

The CSIR Foundation Day on 26th September, 1996 was celebrated with gusto and vigour by the HQs and all the laboratories. The main function of the CSIR celebrations was held in the forenoon at the NPL auditorium. Prof. Y.K. Alagh, MOS (S&T) and VP, CSIR presided over the function. The Foundation Day lecture, the tenth in the series, a break from the past trends, was delivered by Shri S.M. Datta, Chairman ASSOCHAM and formerly Chairman, Hindustan Lever Ltd. In keeping with CSIR's tradition of rewarding excellence in science and technology, at this special function, the highest national level recognition for contributions to science and technology, the prestigious Shanti Swarup Bhatnagar Prizes, for the year 1996 were announced and those for the year 1995 were presented as also the 1996 CSIR Young Scientists Awards and the 1996 CSIR Technology Awards for in-house merit recognition.

In his opening remarks DGCSIR reiterated the Councils resolve to respond proactively to change. The White Paper **CSIR 2001 – Vision & Strategy** was a manifestation of CSIR's responsiveness to change, he stated. He gratefully appreciated the Finance Minister's mention of CSIR in the Budget speech to Parliament, and his pronouncement that he will match every commercial rupee that the CSIR earns incrementally in the next two years with another rupee from the Budget. He said CSIR had geared up to take advantage of the opportunity.

Shri Datta had chosen **'The Emerging Role for Technology'** as the theme for the Foundation Day Lecture. He said over the five decades, CSIR had grown enormously, and so had the Indian industry. But their paths had remained distinct and divergent and very rarely met. In the present scenario where technical and technological prowess was the main driver of economic growth, this divergence between industrial research and industry had to be done away with, he said. Hence, a re-appraisal of the extent of technology development

and its harnessing to subserve the country's social, economic and industrial needs was pertinent. He felt that CSIR's charter, drafted more than half a century ago, was valid and appropriate even in the liberalised techno-economic environment of the day. He said, while it was satisfying to note that the CSIR had not shifted its objectives it was somewhat disturbing that the methodology and process of achieving its objectives had remained practically unaltered over this time. The harsh realities of economic development and liberalisation required the Indian industry to upgrade its technology content, not only to counter the lowering of tariff barriers but also to meet the challenge of intensified domestic competition. The technology change however was a **gain-loss paradigm** in which the potential gainers supported the introduction of new technology, whilst the potential losers opposed the move with vehemence. This, he felt, provided further opportunity to CSIR for fulfilling its charter. However, he felt the change process needed to be expedited because the yawning technology gap had to be bridged within a finite and short period of time. The technology change must also cater to the national priority of job creation by paying attention to the labour intensive small and medium enterprises. Further, in order to gain wider social acceptance, the change process must emphasize on diffusion of low technologies amongst a population that lacked familiarity which the language of technology.

Although science and technology had become closely interwoven, the two branches of knowledge were quite separate and distinct in their practice. Indeed, the history of human development had clearly demonstrated that technology had predated science by a wide margin. Thus, CSIR needed to organise itself to cater to its twin objectives of scientific and industrial research, by adequately restructuring its activities. A degree of accountability had to be introduced in the conduct of basic scientific research, while the major part of activity directed towards supporting technology development, had to be judged by the impact of technological output. CSIR has thus to set its programmes, develop its strategies and action plans for achieving these goals and finally to restructure its organisation in the light of these new programmes and strategies. Therein he said was the key needed to emerge from the comforts of satisfactory under-performance into the demanding world of stretched objectives and achievements.

Prof. Alagh, VP, CSIR stressed on scientific knowledge as basis of economic, industrial and social progress.

Nurturing excellence in science and technology, he felt, was equivalent to building human resource of a very high level. He appreciated CSIR's efforts in this great enterprise and hoped this excellence will transcend national limits and become world class. He then dwelt on fostering excellence at the working level. He was confident that the managers of science and technology in CSIR would ensure an environment of academic freedom, an environment in which the spirit of inquiry supersedes all other conditions.

On the Foundation Day it is customary of the CSIR to reward and honour its family members. Accordingly at a function held in the CSIR HQs Auditorium, the HQs staff who superannuated during the year and also those who completed the Silver Jubilee in the service of CSIR were honoured with mementos (wall clocks and wrist watches respectively) presented by DG, CSIR. Beginning from this year a special felicitation for persons who had served CSIR for 40 years or more was organised and Shri NR Rajagopal, Head, HRDG who completed a little more than 41 years of service was honoured with a memento, a shawl and a citation. This was preceded by the presentation of the prizes to winners of the various competitions held in observation of the Hindi Fortnight during Sept. 12–16, 1996; the cash awards to children of staff securing 90% or more marks in each of the three science subjects in the science groups

at the Senior Secondary Exan inations and the Studentships to those securing admission in IIT during the year. At the laboratories, in addition to the presentation of mementos, for service rendered outstanding contributions and service was recognised and rewarded through commendation certificates and cash prize. Most laboratories observed an 'Open Day' for visitors. Several thousand students from schools and colleges as also general public visited the laboratories. A few laboratories also organised science exhibitions and special lectures on scientific topics of public interest.

## Parliament Standing Committee on Science & Technology

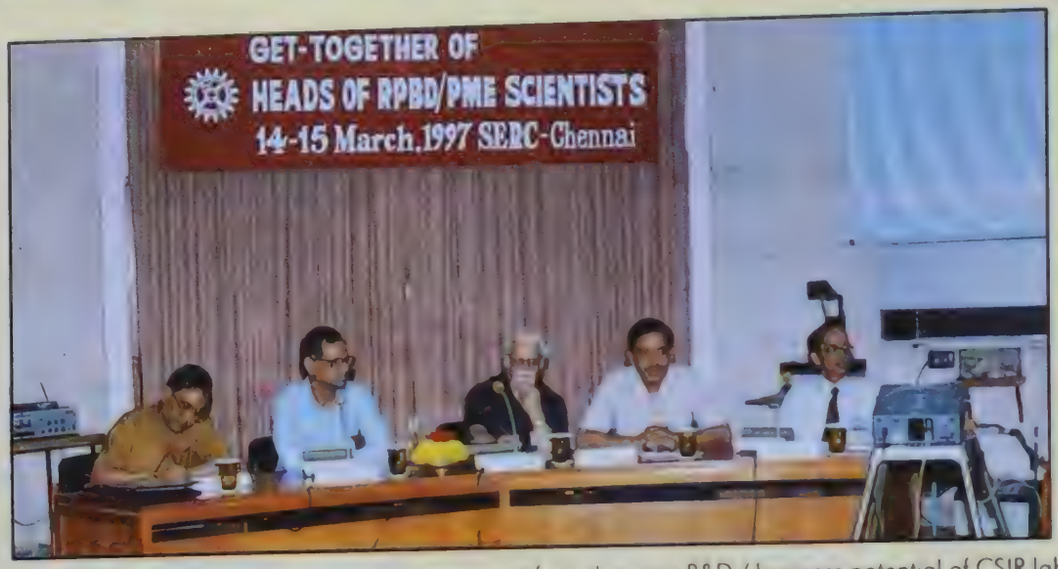
The Department Related Parliament Standing Committee on Science & Technology and Environment & Forests examines the demands for grants of the DSIR including the CSIR and from time to time it takes up for examination of specific topics/subjects of interest.

**Demands for Grants:** The Committee took up the consideration of the Detailed Demands for Grants for 1996-97 of DSIR on August 13 and 22, 1996. A background note on Demands for Grants for DSIR including that for CSIR was prepared highlighting the details of the activities, projects, programmes and financial performance and outlays. The Committee in its Report on the Demands for Grants for 1996-97 made several observations. Salient among the observations made are:

- with increasing cross-linkages between industry, research institutes and universities efforts be made to check possible trends to prioritise applied R&D and to relegate research in fundamental sciences to the background,
- CSIR be allocated adequate funds to enable it to meet its committed liabilities under non-plan so that the need for diversion of plan allocation does not arise and the plan funds could be utilised for their primary purpose,
- CSIR should vigorously pursue the programmes under Technology Missions and initiate steps to launch the Mission on Clean Coal Technologies without further delay,
- reduce the gap between the transfer of technology from laboratory to market so as to maximise the fruits of scientific research,
- considering that housing was a pre-requisite to attracting talented scientists CSIR should take action, in a stipulated timeframe, to reach satisfaction level of housing on priority basis.

**Visits to CSIR laboratories:** The Committee visited the CSIR laboratories in the south, namely the CCMB, CFTRI, CLRI, IICT, NAL, NGRI and SERC-M during February 1997. The visit was co-ordinated by the CSIR Parliament Unit in close liaison with the senior scientists of the HQs. and the laboratories concerned. The documentation of the functions and performance of the laboratories for the Committee's appraisal was prepared by the RPDB Division. A brief but comprehensive write-up for each laboratory highlighting the mandate, major R&D programmes, significant achievements, major facilities, S&T services rendered, statistical data on manpower and financial position was prepared based on the information supplied by the laboratories and supplemented by HQs knowledge base. At each laboratory the Committee interacted with senior scientists and apprised itself of the major research programmes underway and facilities available. The Chairman, Shri V. Narayanasamy, suggested that talented young scientists be given appropriate training to build up a capable manpower to meet the future challenges. He also opined that there was need to modernise the laboratories and its research facilities and also augment manpower in certain areas.

# Headquarters Activities



Strategic policy planning and project management for enhancing R&D / business potential of CSIR laboratories: (left) Dr TVSR Appa Rao, Director of host laboratory inaugurating the two day get-together of the Heads of RPBD/PME cells of CSIR laboratories to discuss the issues with special reference to the Ninth Plan and (right) Resource person Sri PK Biswas, Joint Adviser (S&T), Planning Commission interacting with the participants

Celebrating three decades of CSIR-DAAD co-operation Dr Stephan-F von Welck, Counsellor (Science Technology & Environment) Embassy of FRG, New Delhi, participating in the inauguration of the Indo-German Symposium on 'Organic Synthesis – Growing Interface with Adjacent Sciences' at IICT Hyderabad.

Prof. Vattimo of university of Turin and Dr RA Mashelkar Co-chairing the Indo-Italian Round Table Meeting on Science & Ethics organised to commemorate the 50th Anniversary of diplomatic relationship between India & Italy.

Strengthening the CSIR-CNRS partnership. Dr RA Mashelkar, DGCSIR & Prof. Guy Aubert, DG, CNRS signing the Agreement and the Working Programme providing for collaboration in R&D

# R&D Planning and Business Development Division (RPBD)

Preparation of the Ninth Five Year Plan and finalisation of the Annual Plan 1997-98 for CSIR in collaboration with the Planning Commission and allocation of the plan funds to the laboratories were the major activities of the Division under its portfolio of R&D planning. As a facilitator of promotion of business development and marketing of CSIR knowledgebase and brand equity, concerted efforts were put in to interact and liaise with financial institutions, user agencies, government departments, industry associations and technology brokers/ licensors. Promoting the adoption of Good Laboratory Practices (GLP) and culture of 'Safety' in laboratory work to enhance the international competitiveness of CSIR laboratories was taken up. The Division continued to maintain information on CSIR's R&D output and its utilisation. During the year a total of 160 licence agreements were executed for commercialisation of CSIR's Intellectual Property, contracts worth Rs.300 crore for R&D and consultancy were in hand. Export of services and technology yielded over Rs. 8 crore.

## R&D PLANNING

### Ninth five year plan & annual plan 1997-98

The Division serviced the Working Group for the formulation of the Ninth Five Year Plan for CSIR and prepared the draft report for the consideration of the Group (see Overview, for details). The Annual Plan 1997-98 for the CSIR was prepared by the Division based on the overall guiding principle adopted for formulating the Ninth Five Year Plan i.e., to invest in basic research that supports CSIR's scientific industrial R&D and undertake other programmes and activities that help realise tangible and traceable benefits for the economy/society so as to realise, within the Plan period a benefit-cost ratio of greater than 1.

The Annual as well as the Five Year Plans were discussed with the Planning Commission, and the outcome was an encouraging commitment for modernisation of equipment & infrastructure in CSIR.

### Business plans for laboratories

The Division organised a Workshop to discuss the elements of construction of business plans and the conceptual business plans drawn up for the HQs. and two of the laboratories. Besides foreign and Indian consultants the participants included officials from financial institutions and concerned government departments. Based on the inputs from the workshop, the preliminary plans were revised and these were subsequently discussed in a select in-house workshop with the foreign consultants. The `learning' experience gained was helpful in, not only finalising the business plans for IIP, CGCRI, IICT and the HQs., but also enabling CSIR acquire professional expertise in the field. CSIR now has the capability to devise business plans for other R&D organisations as well.

### Restructuring Plan for HQs.

The GB in its 142nd meeting had approved of CSIR seeking loan from ICICI under its Technology Support Services Programmes funded by World Bank for Restructuring Plan for CSIR HQs. The Division was the focal point for interaction with ICICI & World Bank. It prepared the document on Restructuring Plan of CSIR and submitted to ICICI for availing

World Bank loan. The Restructuring Plan of HQs. comprising an organisational plan, an infrastructural plan, a human resource plan and a financial plan was subdivided into 12 tasks/activities. A two-tier implementation structure, comprising a High Level Review & Monitoring Committee and Project Committees with designated Task Managers for each of the 12 specified tasks was set up to implement the Plan.

## BUSINESS DEVELOPMENT

### New Idea Fund (NIF) Scheme

The Division invited on a biannual basis, inhouse project proposals for support under the NIF scheme. Fifty three proposals were received and assessed by an expert committee of eminent scientists/ technologists. Three projects, one from CIMAP, Lucknow and two from IMTECH, Chandigarh were identified for support under the scheme.

### International marketing of knowledgebase

The Division helped the laboratories in negotiating and finalising international contracts. Some of the important contracts that were negotiated during the year were: Neste OY, Finland with NCL; Cytomed Inc., USA with IICT & NCL; General Electric Co., USA with NCL; Cargill Inc., USA and NCL; Eastman Chemical Co. ,USA with NCL; Imperial Chemical Industries, UK with NCL and United Technologies Inc., USA with IIP and Fakhruddin Ratlamwala, UAE with CECRI.

The Indo-Phillipines Joint Business Council hosted a meeting with the visiting Philippines business delegation. RPBD was called upon to make a presentation to the delegation on `India's capabilities in the area of Science & Technology.' The presentation emphasised India as a tenable technological source for Phillipines industries and a booklet `Tech-Opportunities from CSIR for Philippines' was distributed to the delegation.

### Annual business meet of business development & marketing personnel

The Division organised a 3-day Business Meet-cum-Workshop at CECRI, Karaikudi in December, 1996 with the objective to benchmark best business practices in-house and discuss common issues and concerns to work out a unified strategy for marketing and business development. The workshop covered `Approaches to Technology Pricing' and `Assessing & Valuing Technology Assets.

### Get-together of Heads of PMEs

A two-day get-together of Heads of Planning, Monitoring and Evaluation Units of CSIR was organised by the Division at SERC, Madras in March 1997. The objective was to create an awareness of the new tools and techniques of project identification, planning, implementation and monitoring. A mock syndicate exercise of SFC/EFC meeting was the highlight of the get-together.

## ENHANCING INTERNATIONAL COMPETITIVENESS OF LABORATORIES

**Good Laboratory Practices (GLP) initiatives:** the Division has been motivating the Biology and Chemistry based CSIR laboratories to adopt and acquire GLP accreditation. A

tutorial workshop for promoting the adoption of GLP was organised at CDRI, Lucknow during April 1996. It was conducted by an NRI expert and 25 scientists from 8 laboratories participated. Arising from this workshop, the participating laboratories have initiated the drafting of Standard Operating Procedures (SOPs) and protocols for GLP.

**Quality System-ISO-9000 Workshop:** a two-day workshop for CSIR personnel was organised to acquaint and educate them on the practices and procedures needed to acquire ISO-9000 accreditation. The workshop was conducted at CFRI and by CFRI personnel, as the laboratory is the first and only CSIR laboratory to obtain ISO-9000 accreditation thus far. Resultingly six other CSIR laboratories got enthused to seek ISO-9000 accreditation and initiated steps towards obtaining the accreditation.

## Polytechnology Transfer Centres (PTCs)

The PTCs located in seven State capitals viz., Ahmedabad, Bangalore, Bhopal, Calcutta, Hyderabad, Lucknow and Patna interact closely with the State Governments and assist tiny and small industrial units in regard to their S&T needs. During the year the PTC staff visited about 780 industrial units to help and assess their technological needs, attended to about 2800 technical enquiries; assisted 700 units in resolving their problems, organised 65 technology demonstration/ awareness/ entrepreneur development programmes in collaboration with the agencies in the States and catalysed the transfer of 33 CSIR technologies.

## CSIR Technology Awards – 1996

The Division received fifteen nominations for 1996 CSIR Technology Awards which were processed through a Technology Awards Selection Committee. Due to stringent and high level of achievement set by the Selection Committee, only two of the seven Technology Awards could be awarded this year. These are:

- Prize for Chemical Technology to IICT, Hyderabad for the development of a comprehensive package, comprising process know-how, basic and detailed design engineering for manufacture of Trimethyl Phosphite (TMP), and
- Prize for Business Development & Technology Marketing to IIP, Dehradun for significantly widening and deepening of the market space for its knowledgebase.

## Internal customer communication and satisfaction survey

CSIR 2001:Vision & Strategy was enunciated in January 1996. A survey was taken up with a view to ascertain its awareness and acceptance in the organisation. Accordingly the Division sent out personal letters from DG, CSIR to 1265 staff members covering all the 40 laboratories and the HQs. The letter carried a questionnaire to assess the level of awareness of developments in CSIR and thus the efficacy of internal communication system as also the motivators and the barriers to realising the CSIR Vision. Response received from over 50% of the respondents was analysed and discussed at the Directors' Conference. The salient conclusions drawn were :

- Communication should transcend the printed word to include the visual and multimedia systems well.
- CSIR should engage professional media experts to help in communications-management, both internally and externally.

- NISCOM should be charged with bringing a Report of the developments in CSIR different from the normal Annual Report.
- CSIR should establish its own communication network and allow its free use – this would help foster in organisational learning.

## International S&T Affairs Directorate (ISTAD)

The scope of ISTAD's activities was enlarged by assigning it the responsibility to co-ordinate the UNDP-GOI Umbrella programme. Special efforts were made to revive the agreements operating in low key besides formalising co-operation through new agreements with countries having mutual S&T interests. Among the new activities initiated.during the year are the institution and networking of the International S&T Affairs Groups (ISTAGs) in the laboratories for effective HQs - laboratory interfacing; compilation and dissemination, nationally and internationally, of the trainer potential of CSIR; initiation of a programme for foreign language learning for CSIR scientists and a course on preparation of deputation reports.

### BILATERAL CO-OPERATION IN SCIENCE & TECHNOLOGY

CSIR continued to partner more than 40 bilateral programmes with as many as 30 countries, besides being a major player in inter-governmental agreements signed by the Department of Science & Technology. During the period under report, CSIR signed agreements with Consiglio Nazionale delle Recerche, (CNR), Italy; Centre National de la Recherche Scientifique, (CNRS), France; Thailand Institute of Scientific & Technological Research, (TISTR), Thailand; Royal Nepal Academy of Science & Technology, (RONAST), Nepal; Korea Research Institute of Chemical Technology, (KRICT), Korea; Czech Academy of Sciences and Slovak Academy of Sciences. Highlights of some of the programmes are given here.

#### China

There was a spurt of activities between NAL and Chinese Aeronautical Establishment (CAE) for joint co-operation in the area of Civil Aeronautics. The highlights include the third NAL-CAE Workshop on Composite Material organised at NAL, Bangalore in April 1996; and the second Joint Committee meeting held in October 1997.

#### Germany

Three decades of CSIR-DAAD successful partnership was celebrated by organising two of the three joint workshops planned for the purpose. A workshop on 'Advances in membrane science & technology' was organised at CSMCRI, Bhavnagar in February 1996 which resulted in formulation of a collaborative project on phenol recovery between IIP, Dehradun and GKSS Research Centre, Germany. A symposium on `Organic synthesis - growing interface with adjacent sciences' was organised at IICT, Hyderabad which resulted in formulation of joint projects on pheromones, chlorofluorocarbons and heterogenous catalysis.

## INTERFACE WITH NATIONAL, REGIONAL AND INTERNATIONAL AGENCIES

### COMMONWEALTH SCIENCE COUNCIL (CSC)

CSIR represents India at the CSC. It continued to contribute to all the three flagship programmes of CSC namely, water, energy and biodiversity. Additionally, CSIR played a leadership role in the project 'Chemical research for environmental needs'.

### European Union

CSIR is actively involved in discussions between India and the European Union (EU) for collaboration in Science and Technology in the S&T sub-commission. In the India-S&T working committee meeting at Brussels, during December 1996, the fourth framework programme of EU was discussed and also the opportunities of cooperation with developing countries like India under INCO-DC programme.

### Indo-French Centre for the Promotion of Advanced Research (IFCPAR)

CSIR is a major beneficiary of IFCPAR programme. Of the twentyfour projects funded by the Centre, about eight projects already stand completed. As a result of this joint research two patents have been filed in India and two in France. CSIR also contributed a working paper which helped to shape the IPR policy of the Centre.

### UNDP-Govt. of India Umbrella Programme

CSIR continues to co-ordinate the TOKTEN, UNISTAR and TCDC Umbrella Programme on behalf of Government of India. An implementational innovation has been the unification of TOKTEN, TCDC and UNISTAR components of the programme, regional networking and initiatives towards achieving sustainability of the programme. Two major international workshops, one on 'Hydrogen Energy and Related Technologies' and the other on 'Application of online Instrumentation in Pulp & Paper, Leather and Food Processing Industries' were organised. Additionally, seven experts visited India under independent stream of TOKEN. The areas in which the visits took place relate to advanced ceramic materials, process technology, food processing for value addition; development of novel synthetic processes for pharmaceuticals, medical physiology, molecular and cellular mechanisms of cell injury, application of biotechnology in health and molecular biology and recombinant DNA technologies. The experts made valuable contributions to the ongoing projects in the laboratories visited by them.

## HUMAN RESOURCES DEVELOPMENT

During the year, ISTAD facilitated foreign deputation of nearly 700 CSIR scientists, of these, around 230 were deputed for participation in international conferences/seminars, 55 for training abroad, 200 under bilateral exchange programmes, 82 under fellowships and on leave,113 under adhoc visits and 19 as experts for UNDP project. Partial travel assistance was granted to nearly 300 non-CSIR scientists for participation in international conferences/ symposia/seminars of relevance to CSIR. Six CSIR scientists were awarded the Raman Research Fellowhships of CSIR to work abroad (3 to 9 months) in the R&D priority/thrust areas. A total of 20 participants from Egypt, Thailand, Turkey, Saudi Arabia, Sri Lanka, Myanmar, UK, China and Bangladesh were trained by CSIR. The areas of training covered varied fields viz., Mass Spectroscopy, Metallography, Mining, Tissue culture and Natural product chemistry.

Besides, CSIR and TWAS, Italy joined hands for providing fellowship to six scholars from developing countries to work at CSIR laboratories as post doctoral fellows.

### Training programmes

Two programmes on the preparation of foreign deputation reports were organised by ISTAD at NISCOM, New Delhi and at CCMB, Hyderabad during October, 1996 and January, 1997, respectively. The workshops were meant to introduce professionalism in writing of reports and also to raise the quality and usability of information content. The programme was addressed to all the CSIR laboratories and administrative and technical issues related to international S&T affairs were also covered.

### Trainer potential of CSIR laboratories

A document, on the title subject was brought out and is being disseminated widely, nationally and internationally, to project the expertise and facilities available in CSIR, for use by external agencies.

### Foreign language course

A programme for foreign language learning for the benefit of CSIR scientists going to the European countries has been initiated. An intensive programme of learning German language was arranged during May-July 1996 for CSIR scientists visiting Germany.

### Guidelines on foreign deputation

The erstwhile Guidelines for visits abroad 1987 was revised and improved and the new 'Foreign Deputation Guidelines 1996' (effective 1st. August 1996) were introduced after due approval of the Governing Body. The revised guidelines apart from improving the procedures has enabled the introduction of several new mechanisms in respect of processing of the deputations.

## Societal & Technological Missions Division (STMD)

The Working Group for the formulation of Ninth Five Year Plan of CSIR had identified eleven programmes that had the potential of being converted to mission mode projects. The Division is pursuing these recommendations. The Division continued to co-ordinate the work of three ongoing mission programmes, namely the Leather. Technology Mission for Sustainable Development (LTM), Technology Mission on Oilseeds and Pulses (TMOP) and Rajiv Gandhi National Drinking Water Mission (RGNDWM).

### MISSION PROGRAMMES CO-ORDINATED

### Leather technology mission for sustainable development

The Division continued its concerted efforts in co-ordinating the LTM, which registered a significant progress during the year with 58 out of total 126 commissioned activities reaching completion. The achievements in particular have been reported under the chapter on leather.

Other important activities of the Division have been :

- A mid term review of the programmes with the help of the Mid -Term Review (MTR) Committee. The Division undertook to publicise the MTR.
- Supplementing the publicity programmes on the significance of LTM. Towards this, an article entitled 'Leather Technology Mission for Sustainable Development Enters Advanced Phase' highlighting the achievements of LTM, was circulated to potential agencies and users for enhancing the awareness on LTM.

### Technology Mission on Oilseeds & Pulses (TMO&P)

CSIR as the nodal agency for Mini Mission II of the TMO&P co-ordinated all the activities related to R&D on post harvest and processing technologies for oilseeds, pulses, oil palm and maize. The Division:

- catalysed a programme for establishment of five demonstration units of 1 TPD modern oil expellers (developed by MERADO Ludhiana) in north-eastern states. This expeller is capable of producing pungent rapeseed oil hitherto possible only through traditional ghanis,
- released technology for modern oil expellers of 10 TPD capacity to two parties.
- negotiated and signed MoUs with three firms for release of technology for establishment of oil palm processing plants of capacities ranging from 1 to 20 tonnes fresh fruit bunches/hour,
- submitted a commercial bid to M/s. A.P. Cooperative Oilseeds Growers Federation Ltd., Hyderabad for estabiishment of a 10 tonnes fresh fruit bunches/hr capacity Oil Palm Mill on turn key basis at Ashwaraopet.

### Rajiv Gandhi National Drinking Water Mission (RGNDWM)

CSIR has the nodal responsibility of providing S&T inputs for the control of fluorosis, brackishness, excess iron, arsenic in ground water, water conservation and recharge of ground water. STMD accordingly took up:

- review of the 20 ongoing projects,
- organisation of a national workshop on 'Water Quality Testing Instruments' at CSIO, Chandigarh,
- co-ordination of the major programme on abatement of arsenic in groundwater.

### Clean coal technology

The Division continued its efforts to mobilise the needed resources on consortium basis for establishing an 'Integrated Gasification Combined Cycle Plant' of capacity 60-100 MW. It also sought to forge collaboration between CSIR and CRC (Australia) on using high ash coal for power generation.

## Human Resource Development Group (HRDG)

The HRD Group at CSIR has been contributing significantly to the development of highly qualified S&T manpower at the national level through grant of Research Fellowships (JRFs & SRFs) and Research Associateships (RAs) and also supporting Extramural Research (EMR)

through grants for symposia and travel abroad besides rewarding talent in science by awarding the prestigous Shanti Swarup Bhatnagar Prizes at the national level and the CSIR Young Scientist Awards for in-house excellence.

## Research fellowships/associateships

National Eligibility Test (NET) examination were held twice during the year for selection and award of Junior Research Fellowship (JRF). Nearly 50,000 applications were received for the two NET examinations of which around 50% of candidates took the examination and 19097 were selected for the award of the JRFs.

Award of SRFs and RAs is done through personal interviews by Expert Committees. During the year nearly 60 selection committee meetings were held with the participation of 280 experts. Awards for 478 SRFs out of 1376 applicants and 402 RAs out of 960 applicants were recommended.

Senior Research Associates (Pool Officers) scheme is meant to support highly qualified S&T personnel through temporary placement. During the year 444 SRAs were supported. The number of JRFs/SRFs/RAs supported and renewed is given in the table.

**Table**

| Year | JRF | SRF | RA | SRA |
|---|---|---|---|---|
| 1995-96 | 1123 | 2601 | 1470 | 428 |
| 1996-97 | 1253 | 2681 | 1405 | 444 |

## Extramural research schemes and special support programmes

CSIR provides research grants to scientists/academicians with the objective of improving the overall scientific and engineering research in the country. During 1996-97, 162 research proposals, out of a total of 405 were recommended for support. In addition, 458 ongoing schemes were renewed for 1996-97. The total financial implication worked out to about Rs. 8.79 crore. Eighteen (18) patents were filed on the research supported by these schemes. Sixty four proposals for S&T collaboration between academia and CSIR laboratories were recommended for 1996-97 and support was provided for these schemes.

Financial assistance is provided to superannuated outstanding scientists under the Emeritus Scientists (ES) Scheme to enable them to pursue R&D or write books/monographs. In addition to 105 ES schemes renewed in the year, 29 new ES schemes were approved for support. The total grant sanctioned was to Rs. 1.6 crore.

Twenty five Visiting Associateships were awarded to guest scientists from outside CSIR to enable them to make use of the advanced R&D facilities available in the CSIR system.

Nearly 430 applications for travel grant were received from young researchers for presenting papers at the International Conferences held abroad, of which around 250 were recommended. Also 373 proposals from scientific societies/ institutes/departments for seeking

support for organising national/international conferences/symposia/workshops, etc. were received; of these 327 were recommended.

### Shanti Swarup Bhatnagar Prizes 1996

The prestigious Shanti Swarup Bhatnagar (SSB) Prizes for science and technology for the year 1996 were awarded to ten outstanding researchers taking the total of SSB Prizes awarded till date to 313.

### Young Scientist Awards 1996

Four CSIR scientists received the CSIR Young Scientist Award, for in-house excellence in various fields of science and technology. The cumulative number of CSIR Young Scientist awardees till date is sixty five. These Awards were instituted in the year 1987 and the Division this year published a compendium of the Awards made during the decade (1987-1996).

### Intramural training programmes

Two training programmes for enhancing managerial skills of senior CSIR scientists were organised in collaboration with the Administrative Staff College of India, Hyderabad. Fifty scientists from eighteen laboratories were imparted the training.

## Intellectual Property Management Division (IPMD)

The Division has been rendering yeoman service to the laboratories in filing, securing and maintaining Intellectual Property Rights. As a result of the efforts of IPMD to enhance the volume and the value of the foreign patents their number increased to 71 up from 58 in the previous year. It made a beginning in securing other IPRs as well, ten for Copyrights and three for Trademarks. Expertise of the Division was in demand nationally and it represented CSIR on diverse Governmental and non-governmental forums. The emphasis was on programmes pertaining to creating patent awareness and imparting patent literacy. A few training programmes were conducted for in-house scientific and technical personnel and on special requests to external agencies also.

### In-house patent literacy programmes

The division arranged various training programmes for CSIR scientists and other members of staff associated with IP generation and protection. These were for:

- **Co-ordinators of laboratory IP cells:** a one day programme arranged at New Delhi in May 1996 focussed on the importance of IP protection in the present regime. Thereafter week long training programmes for persons from laboratory IP cells were conducted, in July and August 1996, to appraise them of mechanisms of identifying patentable developments and procedural requirements for securing the IP rights for developments in their area of work. This programme also led to the creation of IP cells in laboratories wherever required.
- **Biotechnological inventions and patent laws:** In association with the World Intellectual Property Organisation (WIPO), Geneva and the Department of Biotechnology,

New Delhi the Division p anned four regional workshops on IPRs for biotechnological inventions. These workshops were conducted during the year at IICT, IMTECH, IICB, and NCL. Over 100 CSIR scientists were acquainted with the overall IP aspects governing biotechnological inventions and their protection, besides being exposed to the various aspects of IP management in India and abroad. Topics covered during the training included among others, an overview of the European Commission's New Draft Bio-technology Directive, use of patent information for stimulating R&D, licensing of biotechnological inventions, legal protection of bio-technological inventions with special reference to human cells and genetic material.

## Unit for Science Dissemination (USD)

The unit for Science Dissemination significantly enhanced its interaction with the media for disseminating the R&D output and achievements of CSIR. USD issued 15 press release, held 5 press meets and organised visits of 5 press parties to various laboratories. Other media used for direct dissemination of S&T achievements were national and international exhibitions/ expositions. Some of the exhibitions/expositions participated in were:

- Chinese Technology Showcase Exhibition organised by Asian and Pacific Centre for Transfer of Technology at New Delhi in April, 1996.
- Mystique India '96 Exhibition, New Delhi in September, 1996.
- Life 2000 Exhibition organised by the WISITEX Foundation at Mumbai in October, 1996.
- TECHMART Exhibition organised by National Small Industries Corporation at New Delhi in November, 1997.
- India Trade Exhibition organised by India Trade Promotion Organisation at Kathmandu (Nepal) in March, 1997.
- PETROTECH '97 Exhibition at Vietnam in March, 1997.

Realising the TMOP objectives - 'Concept to commercialisation of technologies': (Centre) Dr R A Mashelkar, DGCSIR presiding over the function for executing the MoU for turnkey project for palm oil mill. Signing the MoU are (Left) Sri Dinesh Kumar, Managing Director for AP Oil Federation and (Right) Dr AD Damodaran, Director RRL, Tvm. for CSIR

Creating patent awareness among CSIR scientists (Left) Dr V Gowarikar, VC Pune University delivering the inaugural address at the third regional workshop on 'IPRs for Biotechnological Inventions' at NCL, (Right) Expert from WIPO Dr RS Crespi, IP consultant from UK and Mr. Aain Gallochat, Head Legal Department, Pasteur Institue, Paris pattaking in a technical session.

CSIR Annual Awards Distribution function during the celebration of CSIR Foundation Day on 26th Sept. 1996: (left) Dr RA Mashelkar, DG, CSIR welcoming the gathering (centre) CSIR Awardees with the SSB Prize winners seated in the front rows (right) CSIR Young Scientistfor 1996 with Prof. YK Alagh, VP, CSIR and Shri SM Datta, Chief Guest.

## RESEARCH PERFORMANCE DATA 1996-97

| Laboratory | PAPERS | PATENTS FILED | | PATENTS SEALED | |
|---|---|---|---|---|---|
| | | In India | Abroad | In India | Abroad |
| CBRI | 34 | - | - | - | 2 |
| CBT | 26 | 7 | 1 | 1 | - |
| CCMB | 75 | 1 | 1 | - | - |
| CDRI | 125 | 7 | - | - | - |
| CECRI | 94 | 7 | - | 4 | - |
| CEERI | 55 | 2 | - | - | - |
| CFRI | 36 | - | - | 7 | - |
| CFTRI | 142 | 6 | - | - | - |
| CGCRI | 50 | 7 | 3 | 8 | - |
| CIMAP | 76 | 11 | 3 | 1 | - |
| CLRI | 85 | 2 | 2 | 1 | - |
| CMERI | 11 | 1 | - | 1 | - |
| CMRI | 113 | 5 | - | 1 | - |
| CRRI | 75 | 1 | - | 1 | - |
| CSIO | 9 | 1 | - | - | - |
| CSMCRI | 38 | 2 | - | - | |
| IICB | 15 | 3 | 9 | 1 | - |
| IICT | 87 | 13 | 8 | 3 | 1 |
| IHBT | 139 | - | 2 | - | - |
| IIP | 27 | 3 | - | 1 | 1 |
| IMT | 33 | 4 | - | - | - |
| INSDOC | 15 | - | - | - | - |
| ITRC | 43 | 1 | - | - | - |
| NAL | 76 | 3 | - | - | 1 |
| NBRI | 97 | 2 | 3 | - | - |
| NCL | 262 | 78 | 20 | 28 | 11 |
| NEERI | 85 | 2 | - | 2 | - |
| NGRI | 128 | - | - | - | - |
| NIO | 71 | 1 | - | - | - |
| NISCOM | 4 | - | - | - | - |
| NISTADS | 47 | - | - | - | - |
| NML | 117 | 6 | - | 15 | - |
| NPL | 66 | 3 | 10 | 2 | - |
| RRL (BHO) | 26 | 4 | - | 4 | - |
| RRL(BHU) | 126 | 2 | - | 1 | - |
| RRL (JM) | 36 | 5 | 3 | 1 | - |
| RRL (JT) | 69 | 7 | - | 3 | - |
| RRL (TVM) | 79 | 4 | 3 | 5 | - |
| SERC (G) | 21 | - | - | - | - |
| SERC (M) | 97 | - | - | - | - |
| CSIR (Scheme) | | 8 | 3 | 1 | |
| | 2810 | 209 | 71 | 92 | 16 |

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